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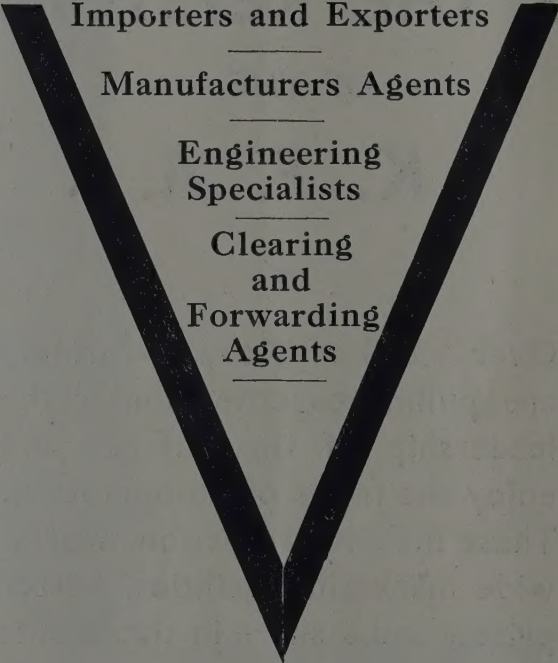
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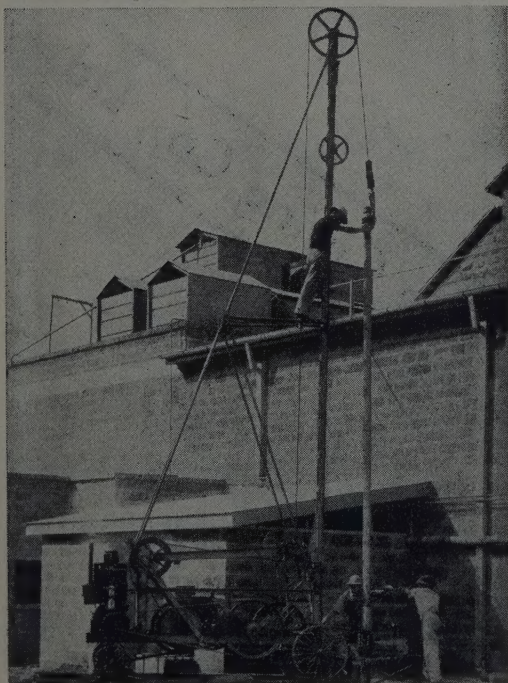
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Readers are reminded that all agricultural inquiries, whether they relate to articles in the *Journal* or not, should be addressed to the local Director of Agriculture, and not to Amani.

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THE EAST AFRICAN AGRICULTURAL JOURNAL

*Issued under the Authority of the East African Governors' Conference and published every three months—
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FOREWORD

The impudent and much maligned goat may come into its own some day, largely as the result of investigations made by the Mpwapwa workers who have demonstrated the potentialities of this hardy beast as a controller of bush and a provider of milk and meat in tsetse-infested areas. In a country where tsetse abounds and in consequence most of the native population do not get enough animal products, a realization of these potentialities would be a boon to native and European alike. For example, we know of one enterprising European farmer in tsetse country who has turned this knowledge to good account and is said to be doing well from his large flock of goats while, at the same time, helping to satisfy the local natives' craving for meat. Having discerned the possibilities of the goat, the next step is to improve the stunted local type, but before that can be done it is essential first to improve the animal's environment. M. H. French in his highly practical article shows how this can be done through knowledge of the goat's food requirements for maintenance and production.

Before our agricultural research workers in East Africa embark on their post-war programmes, which we hope will be on a greatly expanded scale, we should like to see a pause to allow time for the preparation of digests and critical reviews showing our present state of knowledge, or ignorance, in the case of each of our principal crops and each branch of agricultural science. In this way we should get a clear picture of the present position. The preparation of these reviews at short notice would be a vast undertaking which could only be carried out by the temporary employment of a dozen or more capable abstractors whose job it would be to compile annotated bibliographies, foreign as well as British, and to follow this by a careful sifting of all the relevant facts disclosed in the literature of each crop or subject. An admirable example of this type of annotated bibliography and critical review, by R. E. Moreau, is presented in this number, the subject chosen being derris agronomy. In our opinion, this is exactly what is needed for other crops and subjects. Given the necessary means, the proposed Research Abstracts Service of the East African Agri-

cultural Research Institute would, in time, provide what is wanted.

Few people outside these territories realize the vast amount of thought and sustained effort devoted by the East African agricultural departments to increasing food production during the war. Most of the work involved has fallen on the agricultural officer who has right nobly shouldered the increased burden of work and the sacrifices entailed. We are pleased to be able to publish an excellent account, by F. A. Wilson, of one of these campaigns, in this case in Zanzibar, where the problem of increasing food supplies was made more difficult because many of the people had become dependent on imported food and consequently had almost forgotten how to grow their own. One of the features of this campaign was the concentration on one crop at a time. It was a noteworthy success, as can be judged by the fact that the threatened danger of hunger was averted and the rural population was made almost independent of external supplies of staple foods. The article provides further evidence, if any is needed, of the value of cassava as a reliable provider of starchy food, even in years of drought. Its admitted deficiencies can be largely made good, as they were in Zanzibar, by growing appropriate subsidiary crops.

For many years past we have been exploiting—some might call it developing—our natural supplies of mvule, or iroko, the most important hard-wood in tropical Africa, East or West. Unfortunately attempts by our forest departments to ensure future supplies by establishing plantations have usually met with little success, largely because of the damage caused to young trees by the mvule gall. In his article on mvule-growing N. V. Brasnett gives an interesting account of the attempts made to establish mvule plantations in Uganda and shows that, given favourable conditions and adequate care, it is possible to succeed with this crop, in spite of the gall pest.

We wish to invite particular attention to the note by C. G. Hansford on what appears to be a new and serious virus disease of sweet potatoes. Should this disease assume epidemic proportions in East Africa it might have very serious consequences in those areas where the population depend to any large extent on this crop.

THE FEEDING OF GOATS

By M. H. French, M.A., Ph.D., Dip. Agric. (Cantab.), Veterinary Department,
Mpwapwa, Tanganyika Territory

(Received for publication on 20th June, 1944)

Not many years ago goats were the most reviled of farm animals; they were blamed for denuding soils and accelerating erosion, and notices to the farming community advised against the keeping of these destructive animals. Now the pendulum is fast swinging in the opposite direction and goats are advocated as most useful animals for keeping down weeds and bush growth and for being able to live and produce milk under conditions of light tsetse-fly which preclude successful cattle-farming. When the campaign against goats had been waged for some years it became obvious that they were not a major factor in producing erosion and Hornby [1] was one of the first in East Africa to write in their defence. He pointed out that they were blamed because they were the last farm animals able to earn precarious livings from the weeds and bushes left on eroded land after cultivations and cattle had denuded it of pasturage. Then Staples, Hornby and Hornby [2] produced evidence to show that goats, because of their browsing propensities, were able to keep down weeds and bushes, thereby encouraging grass growth, whereas cattle, on the same type of land, ate out the grass, leaving the weeds and bushes to spread. Lowe [3] recently published an article dealing with the value of goats as milk and meat suppliers in areas where cattle are out of the question owing to tsetse-flies. Because of their potential value in supplying milk and meat to (a) natives in sleeping sickness concentrations or on the edge of the fly-belts or in east coast fever areas, (b) to Missionaries and other Europeans and Indians living where cattle are not possible, (c) to Asian and native populations in closely settled urban areas, and (d) to natives in heavily cultivated areas where insufficient grazing land is left to support large herds of cattle, more attention must be paid to goat improvement in East Africa, particularly when their meat and milk potentialities are combined with their value for pasture reclamation. As it is quite useless to improve the type of goats without first improving their environment, and the nutritional level in particular, it is important that as much as possible should be known about their feeding.

A search through the available literature reveals that less work has been done on goat nutrition than with other farm animals and consequently less precise information is obtainable. In fact, in many articles written on the

feeding of milch goats in Europe and America the position resembles that which existed fifty years ago for dairy cows in that, instead of stating the animals' requirements in terms of starch equivalent, digestible protein, digestible nutrients or calorie values, they are given as so many pounds of roughage, green foods or roots and concentrate mixtures. As these foods vary so much in composition from place to place and from year to year, this system is obviously very unsatisfactory, especially as the quantities given are for bigger animals than those in East Africa. Only when the vagueness of many of the articles dealing with goat nutrition is appreciated, is it possible to see the enormous openings for research on this subject and it is hoped that, when peace returns, some of these gaps will be filled for East African conditions.

It might be thought that, in feeding milch goats, the details followed in the scientific feeding of dairy cows could be applied directly, but disillusionment would quickly follow any practical attempt to do this. Goats follow few laws and need treating individually more than other farm animals. They are most inquisitive feeders and few things are left untried if they have free choice—grass, green foods, weeds, leaves, bark, young shoots and seed pods of bushes and trees, paper, cigarette ends and even clothing if left within their reach. Of course the three latter have no practical value, but they emphasize the goat's continual search for variety in its diet. Variety is advisable when feeding any animal, but particularly with goats. Also it is essential to remember that goats browse rather than graze, a characteristic which allows them to fit easily into East African conditions. Browsing enables them greatly to extend the available food supplies, so that they can exist in areas where grazing animals like sheep and cows would quickly exhaust the grazing herbage. It gives them a wider variety of protein materials and thereby diminishes the risk of their efficiency being reduced by lack of essential amino-acids and, since bush leaves are rich sources of minerals, it augments the supply of these important nutrients. Browsing should be encouraged, not only because goats like it but because it is good for them and reduces the need for, and cost of, supplementary foods.

Although systems of feeding applicable to dairy cows cannot be applied directly to goats,

when working out the quantity and quality of concentrate mixtures for milk production, much can be learnt from the nutritive requirements of cows. In addition, the nutritive requirements of goats, especially for maintenance purposes, resemble in some ways those of sheep. Goats, like sheep, thrive on a minimum of concentrates provided that the latter are chosen to meet any deficiencies in the roughage part of the ration and provided that ample opportunity is given for them to obtain a wide variety of browsing and grazing herbage.

Having thus referred to the similarity between goats and sheep nutritional requirements it is necessary to comment briefly on observations made in certain parts of Tanganyika that, in a mixed flock, goats nearly always look healthy, active and in good sleek condition, whilst sheep look poorer and less healthy as they snuffle along with their heads down and their hocks knocking. This difference usually results from differing intensities of internal parasitic infestations. Sheep search for the shorter grasses and so are more liable to pick up heavier worm infestations than goats who nibble weeds and bush leaves and rely less on the moisture and more heavily worm-egg contaminated grasses. Whether there is also a specific difference in resistance to worm infestation between goats and sheep I do not know but, in the case of *Oestrus ovis* infection, goats clear mucus and larvæ from their nasal and sinus cavities more efficiently than sheep which have become weakened and lethargic through worm infestation. Further, the greater the worm population in the alimentary canal the less efficiently will lime and phosphate be assimilated and protein matter digested, and this will favour goats as compared with sheep in this territory.

In comparing sheep and goats, work on basal metabolic rates is interesting. Ritzman and Benedict [4] have shown the basal metabolism of goats to be 22 calories per hour per kilo of body weight and this, when they allowed for the differing surface areas of the animals, gave for the energy required to maintain vital body processes an arbitrary value of 800 for goats as compared with 1,100 for sheep. Goats therefore appear to require less energy to keep alive than sheep but, when the greater activity of goats in climbing for foods and jumping about is taken into account, it is probable that the total maintenance requirements are similar.

MAINTENANCE REQUIREMENTS

The maintenance requirements of goats depend on size and, in Tanganyika, it may be

taken generally that pure-bred goats (British Alpine or Toggenburg) average 130 lb., half-grade goats 90 lb. and native goats 60 lb. live-weight. The maintenance requirements are then:—

	Starch equivalent	Protein equivalent	Dry-matter capacity of stomach
	lb. per day	lb. per day	lb. per day
Pure-bred goats ..	1.5	0.07	4.1
Half-bred goats ..	1.2	0.05	3.2
Native goats ...	0.9	0.04	2.4

Or, if it is preferred to work with standards of digestible nutrients, the maintenance and milk-production requirements can be calculated from Gaines' formula [5]: digestible nutrients (lb.) = $0.37 \text{ F.C.M.} + 0.013 \times \text{weight (lb.)}$ where F.C.M. = the weight (lb.) of milk yielded corrected to 4 per cent fat basis. In the following, the European system of starch equivalent standards has been adopted.

PRODUCTION REQUIREMENTS

For computing the ration for milk production it will be sufficiently accurate to take the figures employed for dairy cows which are, for 1 lb. of milk:—

Percentage fat in milk	Starch equivalent	Protein equivalent
	lb.	lb.
4.2	0.275	0.067
4.7	0.300	0.074
5.2	0.325	0.081
5.7	0.350	0.088

MINERAL REQUIREMENTS

It is not enough, however, to compute rations which supply the requisite quantity of energy and protein matter; other factors are equally important and the first of these to be considered is minerals. The mineral constituents most likely to be in short supply in East Africa are lime, phosphate and salt, although in certain areas supplements of iron, cobalt, and iodine may be necessary to counterbalance deficiencies in the natural herbage. Heavy milking goats are unable to assimilate lime and phosphates sufficiently rapidly to balance the secretion in their milk and they have to draw upon their skeletal reserves. It is necessary, therefore, to see that they receive ample supplies, not only during lactation but also during the dry period, to ensure that the

skeletal reserves are adequate to withstand the drain of lactation. In this connexion it should be remembered that goats show the effects of calcium deficiency very readily and care should be taken to supply sufficient. Green foods, especially leguminous crops and bush leaves, are good sources of lime, whilst seeds and their by-products are rich in phosphates, but even when goats are allowed every opportunity to browse it is advisable to give a supplement of bone-meal mixed in with the concentrate part of the ration. Salt should be fed in the same way or in the form of a lick constantly available to the goats.

VITAMIN REQUIREMENTS

Of the long list of vitamins known, only A, D and possibly E are of practical importance in goat feeding. Supplies of D are usually adequate so long as the animals are allowed out in the sun but, when kept inside for the greater part of their life, goats may suffer from lack of this vitamin which is so essential for the proper assimilation of calcium and phosphorus. Fish-liver oils are the best supplementary sources of supply. Vitamin E will rarely be found in short supply provided that green foods or seeds and their by-products containing germs are fed. Lack of vitamin A may cause trouble if goats are stall-fed for long periods on dried fodders and concentrates without green foods. The easiest way of providing it is to see that plenty of green foods are given. The vitamin A content of the milk will depend on the intake of the goat and if the intake continues low for any length of time the liver stores are depleted and the quantity of vitamin in the milk drops. The colour of cows' milk depends largely on the supply of Beta-carotene (a precursor of vitamin A present in green foods) but in goats' milk little if any Beta-carotene is secreted in the milk, and so the colour of the milk or milk-fat is no indication of the vitamin A potency. Vitamins B and C are synthesized by the goat and therefore less attention is needed to see that adequate supplies are fed.

WATER REQUIREMENTS

Water is another important part of the diet and great care, especially in the tropics, must be taken to see that goats obtain plenty of water. Many milk yields are low because of failure to attend to water supplies and, if possible, water should be available all the time and certainly at several times during the day.

PALATABILITY

Palatability is another highly important, but often neglected dietary factor and efforts should be made to see that the diet of goats is attractive. On no account should salt, condiments or molasses be used to make musty, inferior or damaged foods palatable.

FEEDING STUFFS FOR GOATS

The East African foods on which goats must rely will now be discussed briefly.

Grasses.—Goats will eat considerable quantities of grass but much prefer to browse on leaves and twigs and thrive much better when allowed to browse mixed herbage at will.

Leaves and shoots of weeds and bushes.—Like grass, these are eaten in both the green and dried states and, when animals are stall-fed, it will usually pay to collect bundles of weeds and bush twigs to vary the main diet.

Hays.—Goats live largely on hays when stall-fed in the dry season, but it is important to remember that lucerne and other legume hays are much more valuable and better relished than grass hays.

Green foods.—Green grasses, lucerne, sweet potato vines, maize, cabbage, lettuce, vegetable tops, banana leaves, stems and skins, cacti and edible canna leaves are all eaten readily and form valuable supplements in the dry season.

Roots and tubers.—Kohl-rabi, mangolds, turnips, sweet potato and edible canna tubers and the non-bitter varieties of cassava tubers are readily eaten and are valuable dry-season supplements.

Pumpkins are well liked and are used in the same way as roots.

Silage.—Grass and maize silage alone, together, or with velvet-bean or cowpea vines are convenient forms of feeding succulent fodder when other supplies of green foods are not available.

Legume residues.—The haulms and tops from crops of peas, beans and groundnuts provide a useful change of fodder in the dry season.

Cereal grains.—Crushed maize, oats, barley and broken rice are useful constituents of the concentrate mixture but they should not be too finely ground.

Legume grains.—Crushed cowpeas, pigeon-peas, velvet and dolichos beans are palatable and useful adjuncts to cereal grains for making attractive concentrate mixtures.

Cereal by-products.—Wheat, maize, millet and rice brans, dried grains from the manufacture of native beer and the coarser grades of rice polishings can all be used to balance the concentrate mixture, but goats are not fond of finely powdered foods.

Oil-mill residues.—Sesame and groundnut cakes are valuable protein supplements and are well liked by goats. Coco-nut cake can also be used but in smaller quantities because it is less nutritious and swells on wetting in the stomach.

Tree pods and seeds.—Goats eat large amounts of a wide variety of tree pods and seeds in the dry season and some of these, such as the pods and seeds of *Acacia spirocarpa*, *A. benthami* and *A. albida*, are of appreciable feeding value.

Miscellaneous foods.—Salt and bone meal will always form part of concentrate mixtures and, if no concentrate is fed during the early part of the rainy season, bone meal should be made into a lick with salt. Molasses are a useful food and render other foods more palatable, but their value is lowered if they contain much water.

There is thus a wide range of foodstuffs available locally the feeding values of which have already been published [6] and which can be used to vary the diet of goats. Also there is a sufficient variety of foods to enable concentrate mixtures to be designed to supplement the ration of goats allowed every opportunity of browsing and grazing as well as those which are entirely stall-fed.

COMPUTATION OF RATIONS

For the efficient feeding of milking goats a knowledge of the daily milk yield is necessary and also a rough idea of the live-weight. The ration, especially the expensive concentrate portion, should be adjusted to the milk yield. Exact rationing of individuals is neither necessary nor desirable because, if sufficient concentrates are fed to enable maintenance and production requirements to be satisfied with an average consumption of roughages, the animals can be left to adjust the roughage intake to suit their particular appetites. In designing rations it is important to keep down the quantity of concentrates to a minimum, not only because of expense but also because goats, more than other farm animals, need a good supply of roughages if digestive troubles are to be avoided.

Knowing the milk yield and weight of a goat the total nutrient requirements can be

calculated from the figures given earlier together with those for the stomach capacity of the animal. From the latter figure, the first step is to calculate the energy and protein which would be available if roughages only were being fed. From this, not only can the quantity but also the nature of the concentrate required to make up any deficiencies be calculated. With cattle and sheep the calculation is then straightforward but is complicated for the goat by lack of knowledge of the quantities and types of browse herbage consumed. Only limited figures are available for the feeding values of weed and bush leaves but they suggest that no serious error will be introduced if they are taken to have the same feeding value as the natural grass herbage at any given period of the year. This assumption will probably err on the right side during the dry season, but it enables a figure for the roughage nutrients to be calculated from the quantity that is required to satisfy the stomach's daily capacity. Figures are available for the feeding values of grasses.

To illustrate the principles a few examples will be taken for milk goats at different times of the year and different milk yields, employing the figures given earlier as the basis.

(a) *At the beginning of the rains.*—At this time of the year goats allowed free grazing and browsing will obtain from the herbage available more than enough nutrients for maintenance and enough for a certain amount of milk. The herbage may be expected to contain 55 per cent starch equivalent and 10 per cent protein equivalent.

	Pure-bred goats		Half-bred goats		Native goats	
	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.
Nutrients obtained from herbage	2.25	0.41	1.76	0.32	1.32	0.24
Required for maintenance	1.50	0.07	1.20	0.05	0.90	0.04
Available for milk production	0.75	0.34	0.56	0.27	0.42	0.20

Lowe [3] has given the average fat content of goats' milk at Mpwapwa as 5.6 per cent so that if we take the requirements for 1 lb. milk as 0.35 lb. S.E. and 0.09 lb. P.E. it is calculated that at this time of the year the natural grazings can supply nutrients sufficient for 0.75/0.35, 0.56/0.35 and 0.42/0.35 or 2.1 lb., 1.6 lb. and 1.2 lb. milk respectively from pure-bred, half-bred and native goats. Whether these yields will be obtained in practice depends

on the milking potentialities of the animals. If higher yields than these are being obtained concentrates of a starchy nature should be fed as the protein intake is much higher than needed. The method of calculating the concentrates required is given in (b) below.

(b) *Half-way through the rainy season when the grasses are flowering.*—The herbage at this time of the year may be expected to contain 38 per cent S.E. and 8 per cent P.E. Suppose the goats yield $1\frac{1}{2}$ lb. milk daily and that, as a concentrate, crushed maize is to be fed (S.E. = 80 per cent, P.E. = 8 per cent).

	Pure-bred goats		Half-bred goats		Native goats	
	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.
Maintenance requirements..	1.50	0.07	1.20	0.05	0.90	0.04
Production requirements ($1\frac{1}{2}$ lb. milk) ..	0.52	0.14	0.52	0.14	0.52	0.14
Total requirements ..	2.02	0.21	1.72	0.19	1.42	0.18
Available from herbage alone ..	1.56	0.33	1.22	0.26	0.91	0.19
Deficit ..	0.46	—	0.50	—	0.51	—

It is seen therefore that although the herbage can supply enough protein it cannot supply sufficient starch equivalent to allow for $1\frac{1}{2}$ lb. milk to be given. Now if 1 lb. of herbage is replaced by 1 lb. maize the total energy addition to the ration would be 0.80–0.38 lb. S.E. = 0.42 lb. S.E. and so for pure-bred animals 0.46/0.42 or 1.1 lb. of maize must be fed daily. For half-breds the quantity is 0.50/0.42 or 1.2 lb. and for native goats it is 0.51/0.42 or 1.2 lb. maize if $1\frac{1}{2}$ lb. of milk are to be yielded daily without the animal drawing on its body reserves.

(c) *Middle or dry season when the herbage is mature and dry.*—(1) Suppose the goats are yielding 1 lb. milk daily, that they are being given 1 lb. freshly-cut green lucerne and 1 lb. cowpea hay daily, and that a concentrate mixture such as that mentioned by Lowe [3] (33 parts crushed maize, 33 parts groundnut cake, 50 parts cotton seed and 3 parts mineral mixture) is available. The mature herbage at this time of the year will contain 25 per cent S.E. and 3 per cent P.E. whilst the concentrate mixture contains 79 per cent S.E. and 19 per cent P.E.

The herbage with lucerne and cowpea hay supplies enough protein but insufficient energy and some concentrate must be fed. The S.E. of the above mixture is 79 per cent so that for every 1 lb. of herbage replaced by concentrates the energy value of the ration will increase by

0.79–0.25 lb. = 0.54 lb. S.E. From this it is calculated that for pure-bred, half-bred and native goats respectively, 0.54/0.54 or 1 lb., 0.46/0.54 or 0.8 lb. and 0.36/0.54 or 0.67 lb. concentrate are required.

	Pure-bred goats		Half-bred goats		Native goats	
	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.
Maintenance requirements..	1.50	0.07	1.20	0.05	0.90	0.04
Production requirements (1 lb. milk) ..	0.35	0.09	0.35	0.09	0.35	0.09
Total requirements ..	1.85	0.16	1.55	0.14	1.25	0.13
Nutrients from green lucerne (0.3 lb. D.M.)	0.13	0.04	0.13	0.04	0.13	0.04
Nutrients from cowpea hay (1.0 lb. D.M.) ..	0.48	0.08	0.48	0.08	0.48	0.08
Nutrients from herbage if no concentrates are fed ..	0.70	0.08	0.48	0.06	0.28	0.03
Total nutrient intake ..	1.31	0.20	1.09	0.18	0.89	0.15
Deficit ..	0.54	—	0.46	—	0.36	—

(2) Suppose the goats are yielding 1 lb. of milk daily, are receiving 2 lb. daily of edible canna leaves and can be given a concentrate mixture of 2 parts cotton seed, 2 parts maize bran and 1 part sesame cake. The S.E. of the mature herbage will be 25 per cent and of the concentrate 75 per cent, whilst the protein equivalents are respectively 3 per cent and 15 per cent.

	Pure-bred Goats		Half-bred Goats		Native Goats	
	S.E.	P.E.	S.E.	P.E.	S.E.	P.E.
Total nutrients required (as in (1) above) ..	1.85	0.16	1.55	0.14	1.25	0.13
Nutrients from canna leaves (0.4 lb. D.M.)	0.14	0.02	0.14	0.02	0.14	0.02
Nutrients from herbage if no concentrates are fed ..	0.93	0.11	0.70	0.08	0.50	0.06
Total nutrient intake	1.07	0.13	0.84	0.10	0.64	0.08
Deficit ..	0.78	0.03	0.71	0.04	0.61	0.05

Practically enough protein is supplied by herbage and canna leaves but the incorporation of the concentrate to balance the energy deficit will provide ample protein. Thus we calculate that the substitution of 1 lb. herbage by 1 lb. concentrate will increase the ration's energy by 0.75–0.25 = 0.50 lb. S.E. and the amounts of concentrate required for pure-bred, half-bred and native goats are respectively 0.78/0.50, 0.71/0.50 and 0.61/0.50 lb. or 1.5, 1.4 and 1.2 lb. concentrate.

FEEDING FOR GROWTH AND FATTENING

So far the nutrition of milch goats has been considered but it is also necessary to consider the feeding for growth and fattening. The same principles and the same system of computing rations apply, so that with the figures given below it will be possible to design rations for young growing goatlings, mature billies or castrated goats intended for meat production, though it will rarely pay a keeper of milk goats to castrate and rear males for meat.* Surplus males are better killed at birth or sold as soon as possible after weaning as the cost of the milk used for feeding them as kids usually renders their rearing uneconomic. The following figures are taken from the analogous sheep requirements given by Woodman [7]:—

Live weight (lb.)	Dry matter capacity (lb.)	Maintenance Requirements		S. E. for 1 lb. live weight increase (lb.)	P. E. for growth & fattening (lb.)
		S.E. (lb.)	P.E. (lb.)		
20	1.2	0.46	0.02	1.00	0.12
30	1.6	0.59	0.02	1.00	0.14
40	1.9	0.68	0.03	1.25	0.15
50	2.1	0.79	0.03	1.25	0.17
60	2.4	0.90	0.04	1.50	0.19
70	2.7	1.00	0.04	1.50	0.21
80	3.0	1.10	0.05	1.75	0.23
90	3.2	1.20	0.05	1.75	0.24
100	3.4	1.30	0.06	1.75	0.25
110	3.6	1.35	0.06	1.75	0.25
120	3.8	1.40	0.07	1.75	0.25
130	4.1	1.50	0.07	1.75	0.25

THE FEEDING OF KIDS

Kids can either be left to suckle their mothers in the natural way or they can be fed from bottle or pail. Bottle feeding is the better of the last two methods provided that strong rubber teats are available.

If the kids are to be hand-reared they should be allowed to suckle their mothers for the first three days so that they may get the colostrum at the correct heat. They are then removed completely from the nannies and given four feeds a day for the first fortnight, three feeds a day for the next three weeks and then two feeds a day until weaned at 3-4 months old. The milk fed can be either from goats or cows or a mixture of the two. It should be fed warm (103°F.) for the first two weeks and the quantity given should be adjusted to 18-24 ounces daily in the first week. This quantity will be gradually increased to 50 to 64 ounces by the tenth week. If the whole-milk available is insufficient this can be slowly replaced by separated milk from about the fifth week.

When kids are one month old they should be taught to eat hay and concentrates. Plenty of exercise, adequate supplies of green food, appetising concentrate mixtures and scrupulous cleanliness of milk-feeding bottles and pails go a long way towards producing healthy kids. From the age of 10 weeks, the kids should be weaned as quickly as possible.

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* For an account of the stall-feeding of goats see Lyne Watt, this Journal, Vol. 8, pp. 109-111.

THATCHING

Here is an idea for thatching. The purlins should be 14 in. to 18 in. apart, depending on the length of the grass or reeds. Tie the grass into bundles about 4 in. in diameter, making the tie quite close to one end. Get a long bamboo and split into four or five strips. Now tie one end of a bamboo strip to the lowest purlin but one. Take the bundles of thatch,

and straddle each one on the bamboo strip, pushing well down towards the tie, and closing the bundles well up together, so as to make the thatch tight. After you have put on about 18 in. of bundles, tie the bamboo again to the purlin and continue as before. This method takes less thatch, is quicker and the thatch never slips.

W. L. JACKSON.

DISINFECTION OF CEREAL SEED

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With the exception of the Loose Smuts of wheat and barley all the important seed-borne diseases of cereals can be controlled by one or other of the chemical treatments which, in normal times, are available to the farmer. The cost is small compared with the benefits obtained. Routine seed disinfection is an insurance with an absurdly low premium.

The modern practice of seed disinfection can be said to have originated in the 18th Century when seed wheat was steeped in salt water and afterwards dried with lime as a preventive of Bunt which, at that time, took a heavy toll of the wheat crop. This method followed the experiments of Tillet in France while, at about the same time, the idea occurred to Jethro Tull in England as a result, it is said, of planting wheat salvaged from a wrecked ship. Early in the 19th Century, Prevost discovered the fungicidal action of copper salts. For many years steeping seed wheat in a solution of copper sulphate was the standard practice. The copper sulphate treatment, which was likely to damage the vitality of the grain, was later displaced by the formaldehyde treatment discovered about 1895. Formaldehyde, not only prevented Bunt of wheat, but was also effective against the smuts of oats and the Covered Smut of barley, which were not satisfactorily controlled by copper sulphate. The greater efficiency of the formaldehyde treatment is due to the liberated gas penetrating between the husks of oats and barley and thus killing the spores which escaped the copper sulphate solution.

Since about 1906 inorganic salts of mercury had been used in Germany. The first mention of an organic mercury salt, the forerunner of the now universally used "organic mercurials", occurred in 1913. In the early nineteen twenties, "Uspulum" and "Germisan" in Germany and "Chlorophol" and "Semesan" in America, appeared on the market. These and other later preparations were first used as steeps much in the same way as the earlier copper sulphate and formaldehyde. The process was simplified by a "short-wet" method, originated in Germany, by which the seed could be treated with a small quantity of liquid, 1-2 pints to the bushel, in a mixing machine in about three minutes without the necessity for subsequent drying.

Meanwhile, as the development of the organic mercurials progressed, trials were being

made, at first in Australia and later in America, of treating the grain with a powder instead of a liquid. The powders used were copper carbonate or a mixture of anhydrous copper sulphate and lime. Copper carbonate gave a good control of Bunt and Flag Smut of wheat and rye, but was not so good for barley and oat smuts. In view of the ease and speed with which the grain could be treated this method became popular in America but in England, even as late as 1930, it was described in a Ministry of Agriculture Bulletin (No. 24) as a "new method".

The obvious advantages of the dust over the wet treatment led to the manufacture of the "organic mercurials" in the form of dusts. These dusts, of which a number are now on the market, are greatly superior to the copper carbonate, are easy to handle, and control not only Bunt but most other seed-borne diseases as well. As the manufacture of these dusts has developed, the amount of mercury they contain has been progressively reduced. The modern products now contain as little as 1.5 per cent or less of mercury. Still later developments give promise of non-poisonous dusts, of which Nomersan is already in use against certain diseases of flax, while others incorporate growth-promoting hormones.

The outstanding advantage of the organic mercurial dusts now available, such as Agrosan, Ceresan, Semesan, etc., is that in addition to preventing such diseases as Leaf Stripe of oats and barley, which may be responsible for a poor stand as well as for diseased plants above ground, they appear to have a stimulating effect on germination and vigour of the plants not entirely due to suppression of the above diseases.

The copper sulphate steep or pickle for the control of Bunt in wheat is now rarely used, but readers may like to know the process should other means not be available at the present time. The solution used is of 2½ per cent strength, made by dissolving 2½ lb. of copper sulphate crystals in 10 gallons of water. The seed is heaped on a clean floor or tarpaulin and sprinkled or sprayed with the liquid, while the heap is continually turned with a shovel to ensure that each grain is uniformly wetted. About two gallons of liquid are required for each four bushels of grain. The grain is then spread out to dry and re-bagged in sacks which

have previously been soaked in the solution and dried. This is to prevent re-contamination from used sacks.

An alternative method is to steep the grain in the solution for five minutes, after which the solution is run off and the grain dried as before. Steeping is rather more efficient but the risk of damage is greater.

The copper sulphate treatment is not recommended for oats or barley.

The Formaldehyde Treatment.—Formaldehyde is a gas and is sold as a 40 per cent solution in water as "Formalin". The solution for sprinkling is made by adding one pint of formalin to 40 gallons of water, or one tablespoonful to a gallon. The wetting of the grain is carried out as described for copper sulphate. The wet grain, however, must be covered for four hours with wet sacks soaked in the solution in order to allow the gas thoroughly to act. Care should be taken that pools of liquid do not collect in which the grain can lie. It is then spread out to dry and should be sown as soon as possible, at least within two days. The formaldehyde treatment is to be preferred to copper sulphate. It is a more efficient disinfectant and can be used for wheat, oats, barley and rye. Properly carried out, the risk of damage is negligible unless germination is delayed by sowing in dry soil.

The dry treatment of cereal seed with dusts instead of liquid offers so many advantages that the latter is now rarely used. Dusts are easy to apply and save much labour, and the seed, once treated, can be stored for some weeks before sowing. Copper carbonate was the standard dry treatment for the control of Bunt of wheat. The dust, at the rate of two ounces to the bushel, is best applied by mixing the grain and the dust together in a mechanical mixer which can be made from an oil drum as described below. Copper carbonate is effective in the control of Bunt and Flag Smut of wheat but is not so satisfactory for treating other cereals.

A great advance on copper carbonate is the modern organic mercury dusts whose names usually end with "san". There are several brands on the market; one of the best known in Kenya is Agrosan. To treat the seed, all that is necessary is to add the requisite amount of dust to the seed in the drum (usually two ounces to the bushel) and slowly turn the drum for three or four minutes so that each seed is thoroughly coated with dust. The special physical properties of these dusts make mixing easy and cause the dust to stick to the grain.

Dusting can be carried out at any time and the seed sown when convenient. For efficient dusting, the barrel should not be more than half filled. Hand machines of this type will dress about 12 bushels an hour, but continuous action machines can be obtained which will dress from 50-80 bushels an hour.

It should be remembered that these dusts are poisonous, so that dusting is best done out of doors. If it is done in an enclosed place, it is advisable for the workers to wear a respirator or a damp cloth over the mouth and nose to avoid inhaling the dust. The hands should be washed before handling food.

Flax seed needs special treatment as dust does not adhere so well to the smooth surface of the seed. After dusting, the dust is "fixed" to the seed by moistening it with water by the "short-wet" process. This consists of adding just enough water to cause the mucilage to become sticky but not to wet the seed. Six pints to the bushel has been found sufficient for this purpose. It can be added to the seed in the drum after it has been dusted and the drum turned a few more times, or it can be sprinkled on a heap of dusted seed and the seed well mixed by turning over. The seed can be bagged straight away without further drying. No loss of germination was found after a month with flax seed treated in this way.

A fairly efficient control of Covered Smut of barley can be obtained by dusting with a heavier rate of flowers of sulphur or finely ground sulphur (up to eight ounces to the bushel). It is not, however, an efficient control of other seed-borne diseases of barley, but is a cheap and generally available treatment for the Covered Smut. It can be applied in the same way in a drum or can be mixed by shovelling the grain and the sulphur together on a floor. The sulphur treatment is much used in other parts of the world for the control of smuts of Sorghum.

The Loose Smuts of wheat and barley cannot be controlled by any chemical treatment as the fungus is in the form of mycelium in the grain instead of, as in other diseases, being carried as spores on the outside. The only effective way of controlling these diseases is by the hot-water treatment. This is not a suitable treatment for farmers to undertake themselves. A good deal of apparatus is required and very careful supervision is necessary to make the treatment effective and, at the same time, to avoid damaging the seed. The treatment is used mostly by plant breeders and on seed propagating farms for the elimination of

disease from foundation stocks. Large-scale control of these two diseases can only be attained by selecting for seed such crops as show little or no signs of loose smuts at flowering time.

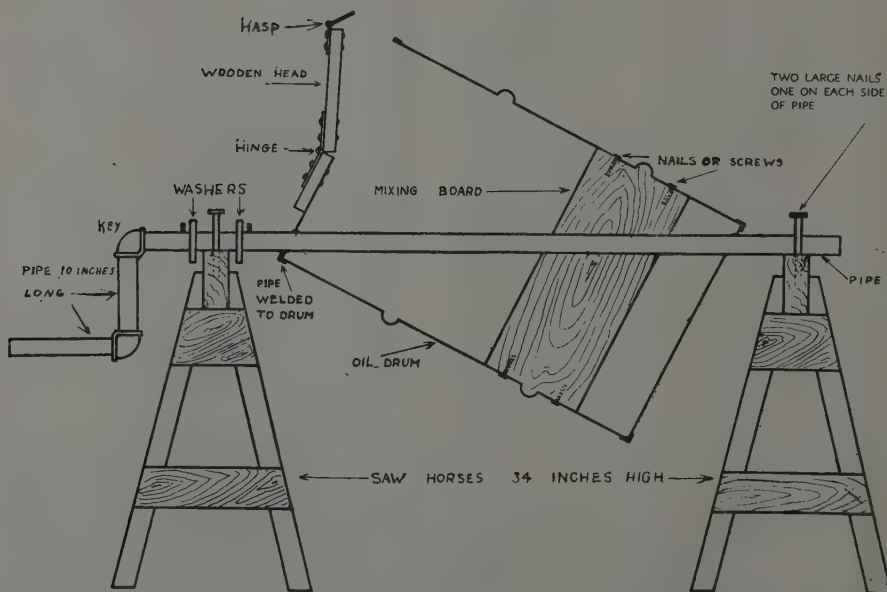
Oil Drum Mixer.—The following instructions for making a mixing machine from a steel oil drum are quoted from U.S. Department of Agriculture Misc. Circular No. 108:—

"A 30-gallon oil drum is a convenient size. Cut out half of one head. Bolt' to the top of the remaining half a board 1 inch thick, 6 inches wide, and the proper length to fit snugly against the inside rim of the barrel. Let one inch of cut edge of steel extend beyond the board. Cut a semicircular wooden head to fit the open half of drumhead and hinge this

to 6 inch strip. If necessary, nail a strip of an old inner tube along the edge of the door to make it dust tight. Attach a hasp to hold the door tightly against the edge of the drum when closed.

The axle is made from $\frac{1}{4}$ inch or 1 inch pipe, 48 inches long, threaded at one end. It should pass diagonally through the barrel and extend about 8 inches beyond each end. It is best to have the drum and axle welded together, but the axle may be bolted to the drum.

Nail or screw a mixing board, 1 inch thick by 6 inches wide, across the full inside width of the barrel. Place the board edgewise and about two-thirds of the way back from the opening as illustrated. Mount mixer on saw-horses."



From design by Pennsylvania State College Agricultural Experimental Station.

DERRIS AGRONOMY: AN ANNOTATED BIBLIOGRAPHY AND A CRITICAL REVIEW

PART I

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(Received for publication on 10th April, 1944)

INTRODUCTION

With the increasing appreciation of the rotenone-containing plants as insecticides, derris is a minor crop that was annually gaining importance up till the end of 1941. Then, within the space of a few months, almost the whole of the world sources fell to the Japanese. The American (United States) market, which was the largest consumer, had been mainly supplied from Malaya, the United Kingdom from the same source, Holland and the other continental users from Java and Sumatra. Practically the only other exporting country, on an altogether smaller scale, was the Philippines. Japan had developed an industry, for her own requirements, in Formosa.

No really up-to-date figures of the exports from the Far Eastern countries are available, and in any case different parcels of root from different sources are not comparable weight for weight because of their different toxic values. Some idea of the extent of the trade in this important minor crop may, however, be obtained from the following figures (extracted from Holman, 1940):—

	Exports of Derris Root (in tons)		
	Total	To U.K.	To U.S.A.
Malaya, 1939	1,456	228	913
Dutch East Indies, 1938 ..	238	93	23
Philippines, 1938	15	—	11

By 1941 U.S.A. requirements of rotenone roots had risen to over 3,500 tons, of which about half was supplied by derris (Moore, 1943). It can therefore be stated that at the time the Far East was lost to the Japanese it was supplying something like 2,000 tons of derris to the Allies.

According to the latest information, East Africa was in 1941, and remains, practically the only source of high-grade derris root in the British Empire. This is surprising, since there is reason to believe that climates at least as suitable as those in East Africa exist in Ceylon, in West Africa and in the West Indies. In Ceylon trials were made for a number of

years but the strains of derris used were so poor in toxicity that the crop was abandoned about 1937. In India, although interest has been taken in the possibilities of the low-grade indigenous *Derris* spp., there has been no commercial production of derris root in the past. According to information kindly communicated by the Imperial Council of Agricultural Research, New Delhi, trials with *D. malaccensis* and *D. elliptica* in various parts of India have now been recommended and one estate, in Coorg, is starting production. In the British West Indies the crop is still under trial, and no interest in derris-growing has been recorded in any of the West African territories, British or other. In the result it appears that of the total British requirements of derris root, Tanganyika, and in fact the Tanga Province, must supply, both now and for some time to come, a very large part indeed. It is to be noted that the U.K. order making the use of derris compulsory in warble-fly dressing has recently had to be suspended (Anon. 1943 c).

America in 1940 drew 49 per cent of its relatively large requirements of rotenone from the Far East. In the U.S.A., there is now such a shortage that the use of rotenone insecticides has been closely controlled. Efforts to supply the deficiency have been directed mainly to switching over to lonchocarpus, production of which is being stimulated in South America,* but Puerto Rico, which has been taking a keen interest in derris since about 1935, is now an important source of this root. There have been frequent references to experimental work in the reports of the Mayaguez station and in 1943 the stage had been reached of issuing a semi-popular circular on derris cultivation (Moore, 1943). It is stated, however, that the relatively high wage of "common labour" in the island prevents extensive planting of the crop there. Also, as will be seen from Table I, the rotenone content of the locally grown root is not very high. Meanwhile, derris cultivation is being extended into Latin America, Guatemala and Panama being mentioned specifically (Anon. 1942; Anon. 1943 b; Higbee, 1943).

* The War Food Administration of the United States expects that the import of lonchocarpus root into the U.S.A. from South American countries will amount to 2,250 tons during the season October, 1943, to October, 1944 (Holman *in litt.*).

The history of derris in East Africa is interesting. Cuttings sent from Kew for trial at Amani in 1928 were from a plant that had been in cultivation in the Royal Botanic Gardens for many years. Its origin was uncertain and nothing was known of its toxic content. By singular good fortune the progeny turned out to be of the Changi type of *D. elliptica*, with a rotenone content that was regarded as good enough not only to form the basis of the derris-growing industry in East Africa but to give the product an established reputation on the world's markets.

While this "Amani clone" was being multiplied a few small importations of inferior planting material were made by estates. In order to secure the standard of the East African root marketed, it was arranged that derris grown locally, except the Amani clone *D. elliptica*, should be eradicated. This is believed to have been done effectively. An incidental result is that all the derris now being grown in East Africa is clonal, a circumstance of value for experimental work and for comparing observations, though inimical to genetical improvement.

Derris is a crop in which chemical analysis of both parent material and of product is essential for any successful cultivation and for any research. It is moreover a crop in which those interested have been embarrassed by the wealth of natural forms that possess the desired active principles in a greater or less degree. Among the several species in which insecticidal properties exist, *Derris elliptica* has achieved a special position in the world's markets by reason of its high rotenone content. *D. malaccensis* has claimed attention because of its high yield of "total ether extract". As a consequence of both the world-wide tendency to aim at high rotenone rather than high ether-extract content, and to the East African concentration on *D. elliptica* of Changi type, the following review is written with special reference to this type of derris.

In the accompanying bibliography I have attempted to bring together all the references dealing with aspects of derris that are of interest to the grower and his scientific adviser. Besides methods of cultivation, pests and diseases, it includes plans for, and progress with, selection, breeding, agronomic and physiological research. It does not cover references concerned with purely chemical technique nor with toxicity tests, a group that greatly outnumbers the references concerned with the production of derris root. For con-

venience I have, however, included a few of the leading references on methods of evaluation and on the effects of derris on vertebrates: also, because of their potential interest from the point of view of selection, as many references as possible that quote analyses. Among the individual references, I have included, under country of origin, those annual report series which contain frequent references to derris.

This bibliography has been compiled, so far as possible, from original sources. Only those references marked with an asterisk have not been available to me. The bibliography given by Holman (1940) has been of assistance, though only a small fraction of it deals with those aspects of derris with which the producer is especially concerned. I am greatly indebted to the Librarian of the United States Department of Agriculture for his ready response to inquiries on this subject and especially for communicating to me Sievers' compilation, which was not published for general circulation. Its bibliography contains 150 titles up to the end of 1938; but a large proportion of them are of unpublished reports in the departmental files and appear to be concerned more with the commercial than with the agronomic side. I have also to thank the United States Consul at Mombasa, the Imperial Bureau of Plant Genetics, and the Director, Royal Botanic Gardens, Kew, for assistance.

In time, the literature of derris-growing is compact. It was only in 1919 (Mc. Indoo and Sievers) that the value of derris as an insecticide was authoritatively recognized. Prior to 1925 practically no interest was taken in it as a crop and so late as 1928 it could still be described as "a comparatively little-known insecticide". In Malaya its growing had then been taken up by only two companies (*Malay. Agric. J.*, 16: 123). By far the greater part of the references to derris-growing are later than 1930. Nevertheless, in perusing the literature one gains a strong impression that the workers in any one country were imperfectly aware of the work being done on derris elsewhere.

In the title of this paper I put the bibliography before the review, partly because that was the order in which the compilation proceeded, and partly because the scope of the bibliography is the wider. But it is more convenient—and more conventional—to print the bibliography at the end. I am indebted to several of my colleagues, especially Mr. L. R. Doughty, for reading the review critically.

LINES OF RESEARCH

Probably the only comprehensive plan of agronomic research on derris is that in Java, outlined by Huitema (1938). The questions he poses may be translated as follows:—

- (1) What is the most profitable spacing?
- (2) What is the economic life of a plantation?
- (3) Is there any seasonal influence on rotenone content?
- (4) What is the most economical planting method: should the plants climb on laths, on support trees or be left prostrate?
- (5) What is the influence of manuring on rotenone, ether-extract content and root production?
- (6) Has pruning a favourable or adverse effect on the rotenone content?
- (7) After digging up a plantation can the old stools be used again for replanting or should they be discarded?
- (8) What is the effect of the season of planting on the growth?
- (9) Under what crops can derris be used as a catch crop?

It appears from Huitema's paper that certain of these problems were the subject of replicated experiments in Java, but apparently not all. He gives "some answer" to certain of them on the basis of preliminary results already obtained at the time he wrote; but on the whole they are disappointingly incomplete and it does not appear that the full results, with evidence of their statistical significance, have ever been published, at any rate for general circulation.* Indeed I have been able to find in literature practically no exact information on his questions 6, 7, 8, 9. (As regards the last, derris has been interplanted, apparently with satisfactory results, in a great variety of crops, from rubber to sweet potatoes and rice.) On the other hand some questions of great interest are not included in Huitema's list, especially the effect of climate on yield and on toxic content.

The review is arranged under the following headings:—

- Selection and breeding (with a table showing the toxic contents attained).
- Variability.
- Climate and derris.
- Shade.

The age for harvesting.

Root character and toxicity.

The effect of manuring.

Yields and spacing.—

(a) Published records;

(b) Unpublished (East Africa).

Propagation by cuttings.

Staking.

Pests and diseases.

Histology and biochemistry of rotenone in derris plants. (This to some extent covers Huitema's question 3.)

It is desirable at the outset to make the cautionary remark that by no means all the statements that have been made, and reproduced, about derris can be accepted at their face value. Most experiments apparently, and many for certain, have not been such that statistically significant results are attainable, conditions are often most imperfectly defined, and in some reports, even of experiments, the species or type of derris used is not stated.

SELECTION AND BREEDING

In Malaya, as elsewhere, selection has aimed especially at high toxic content. By 1937 *D. elliptica* was regarded as definitely more desirable than *D. malaccensis* in any form and attention had been focused on the Sarawak Creeping, Changi and Singapore types. From these Georgi, Lambourne and Gunn Lay Teik (1937) selected *D. elliptica* Changi 3, a "race" already described by Henderson (1934), but previous to that known to the local Chinese growers by a special name. The advantages of the "race" were, besides the highest rotenone and ether extract of all the types examined, ease of establishment and a high proportion of the desired "fine" root (see section 7). *D. elliptica* Sarawak Creeping was also regarded as having useful possibilities because, although the rotenone was much lower, the ether extract was about the same and the growth notably vigorous. Subsequent work in Malaya was largely focused on Changi 3, though the rotenone-ether-extract ration of Sarawak Creeping continued to make it a favourite with buyers (Georgi 1940).

In 1935 clones were being propagated "with the object of endeavouring to combine vigour of growth with maximum rotenone content by hybridization" (Malaya Report for 1935); and

* The Imperial Bureau of Plant Genetics has confirmed this. Moreover the original of the reference to work at Besocki on "effects of cultural measures on rotenone content" (*Plant Breeding Abst.* 11: 92), turns out to be completely uninformative (*Verslag 1938 Algeri. Landb. Synd.*).

by 1938 the hand-pollination of Changi 3 with Sarawak Creeping, of high root-yield, had begun. The results of this breeding do not seem to have been recorded. Work on the same lines has been begun in Puerto Rico (Mayaguez Report for 1938), where also Changi 3 has been budded on Sarawak Creeping and St. Croix types of *D. elliptica* (Moore and Jones, 1943).

The Dutch had a far more ambitious and comprehensive scheme of selection and breeding of derris than other producers. By arranging collection of wild as well as cultivated forms (Toxopeus, 1938), they accumulated a mass of material and they had by 1940 started on large-scale selection and breeding. Their aims were not only high rotenone content and high yield but also good leaf formation, shallow rooting, rapid covering of soil, resistance to pests, diseases and bad weather (Anon., 1941 a).

So far as published information goes, Table 1 summarizes the degree of success attained by the various producer countries in selecting for high rotenone content. This table also includes averages, as an indication of the general level attained by each country's best types of derris, and, for comparison with *D. elliptica*, figures for a good *D. malaccensis*. With the exception of this last, practically no records of less than 6 per cent rotenone are included, because of their minor importance, and the types that had been rejected by the Malayan workers up to 1937 are also omitted. The rotenone percentages quoted are understood to be from plants regarded locally as of the best age for rotenone content (see section 6 below). It is, however, not certain that all the figures are exactly comparable because the analyses do not always specify—

- (a) that the calculation is on a moisture-free (not air-dry) basis;
- (b) the degree of purity of rotenone on which the percentage is calculated. Some examples of the extent to which this factor affects the rotenone percentages reported in high-quality root are given by the Imperial Institute (Anon., 1940 b):—

Sample 1a—Crude 9.8%; purified 8.7

Sample 1b—Crude 9.5%; purified 8.4

Sample 4a—Crude 11.0%; purified 9.3

Unpublished New York analyses communicated to the East African Agricultural Research

Institute, Amani, show comparable differences, viz:—

(i) Crude 10.5%, purified 9.1%

(ii) Crude 13.8%, purified 11.4%

It appears probable that the later Changi 3 selections were not distributed outside Malaya. Such Changi 3 as was available in 1936 went on a lavish scale to Java, Indo-China, Japan, India and Fiji (Malaya Field Report for 1936, p. 106). It is recorded also in Puerto Rico (Mayaguez Report for 1937) and it appears to be this type which is under experimental cultivation in the Belgian Congo (unpub.). No analyses for this last are available, and for the Puerto Rico stock the astonishingly low rotenone percentage of 4.16 is recorded, actually less than with *Derris elliptica* Sarawak Creeping, also in cultivation there. The low rotenone of this particular Puerto Rico Changi 3 is attributed to its being three years old, which is there regarded as past its best age. Whether this opinion is correct or not, practically all the published analyses for Puerto Rico derris compare poorly with those for *D. elliptica* elsewhere, as will be seen from Table 1. Nevertheless, the quality of the root produced in Puerto Rico has been good enough to provide a local industry.

It is unlikely that any of the good Java selections have become available elsewhere. Export of derris planting material from the Dutch East Indies was prohibited as long ago as 1st July, 1938 (Anon., 1938 b).

Although, as shown in Table 1, the published figures for the general level of the Amani clone derris are 9 per cent and 9–10 per cent, it is necessary to record that while on the one hand three samples have actually reached 11 per cent and over, a large proportion, especially of the samples more recently examined, have been under 9 per cent, and an appreciable number under 8 per cent. In view of the Puerto Rico findings (see section 13), it is possible that this may be connected with the unusually dry weather of the last two years.

Meanwhile it appears from the data in Table 1 that the Amani clone of *Derris elliptica*, on which the whole East African production is based, compares favourably with the Puerto Rico and the Philippine *D. elliptica* selections. It may be about as high in rotenone as the unselected Changi 3 as it existed in Malaya in 1937, though not so high as the Java average at the same date. It appears that since 1937 in both Malaya and Java clones had been selected that contained one-third or more rotenone than the East African material.

TABLE 1

THE TOXIC CONTENT ATTAINED

Country	Species and type	Rotenone		Ether extract		Reference
		Average	Highest	Average	Highest	
Malaya ..	<i>D. malaccensis</i> var. <i>sarawakensis</i>	3·5	—	22	—	Georgi and G.L.T., 1937.
	<i>D. elliptica</i> — Sarawak creeping	8	—	27	—	Georgi and G.L.T., 1937. Milsom and Georgi, 1937.
" "	" " " " " "	6	7·5	—	—	Georgi, 1940.
	Changi 3 " " " "	9·2	—	26·4	—	Georgi, 1937a.
" "	" 3 clone 10	13	—	—	—	Georgi, Lambourne and G.L.T., 1937.
	" 3 selected	12·6–13·4	15·2	28·9–30	32·7	Malaya, 1938; Bunting, 1938b.
	" 3 average clones	10·8	—	23·4	—	Georgi, 1940.
	" 3 selected	12·0–12·9	—	25·5–28·4	—	Georgi, 1940.
Java	Not specified	7–13	16·7	20	32	Legros, 1937.
	<i>D. elliptica</i> clones	—	16–17	—	—	Holman, 1940.
	" " " " " "	—	13–14·5	—	—	Anon., 1941.
Philippines ..	<i>D. elliptica</i> D9	—	8·7	—	—	Silayan, 1940a.
	" " " " " " " " " " " "	7–10	—	—	—	Silayan, 1940b.
	" " " " " " " " " " " "	—	9·4	—	40·3	Ejercito, 1939.
Formosa ..	Not specified	6–9	—	—	—	Holman, 1940.
	" " " " " " " " " " " "	6·2–7·4	—	14·7–15·0	—	Anon., 1939b.
Indochina ..	" " " " " " " " " " " "	7–8	—	—	—	Anon., 1937b.
Tanganyika ..	<i>D. elliptica</i> Amani clone	9·0	—	22·8	—	Hill, 1940.
	" " " " " " " " " " " "	9–10	—	—	—	Worsley and Rogers, 1940.
Seychelles ..	<i>D. elliptica</i> " " " " " "	7	—	18·4	—	Anon., 1940.
Puerto Rico..	<i>D. elliptica</i> — Sarawak creeping	5·0–5·8	—	15·2–17·4	—	Moore and Jones, 1943.
	" " " " " " " " " " " "	6·3–6·5	—	—	—	Moore, 1943.
	Changi 3 (budded on Sarawak Creeping and on St. Croix)	5·5–10·4	—	13·3–22·8	—	Moore and Jones, 1943.

VARIABILITY

Much of the reported work is of doubtful value because the variability within the type, and even within the clone, was not adequately recognized. This applies to both toxic content and weight. Koolhaas (1938) in his tables of rotenone and ether extract for plants of selected *D. elliptica* clones gives some striking examples: in Toeba woeloeng a variation in rotenone from 8.5 per cent to 13.4, and in Toeba poeth clone 1 from 2.7 to 7.9. In Malaya it has been stated that "members of a clone vary considerably in rotenone and ether extract, although the average for the mixed roots of a clone is of the same order as in the parent plant" (Malaya Report for 1937). This has been emphasized by Belgrave (Report for 1940), who writes that examination of 18 clones showed that "toxic content was a hereditary character".*

Since the whole of the East African derris is of the Amani clone, it might be made to provide interesting details of variability.

Meanwhile it may be useful to collate, in Table 2, examples, of aberrations of rotenone content within clones of established types. The aberrations are recorded for bulked samples, of at least several plants, except where the figure is marked SP (single plant). Some of the aberrations may be the result mainly of climate. Where single plants are concerned they may have been affected by eco-climatic (positional) factors or by soil factors. The marked insensitiveness of the toxic content of derris to manuring (*see* section 8) suggests, however, that such aberrations may be the result of some relatively obscure element in the nutritional balance. There is also the possibility that the average content of a group or consignment of plants, and of a single plant, may be depressed by the production and inclusion of some coarse root or even by including "knob" in the material analysed. This is probably the main cause of the abnormally low record for the consignment shown in Table 2 from the Tanganika coastal source.

* Since the propagation was vegetative, "transmitted" would be a more correct word than "hereditary".

TABLE 2
ABERRATIONS IN ROTENONE CONTENT OF SELECTED *D. elliptica*

Country	Type or clone	Normal range of rotenone per cent	Reference	Aberrant cases rotenone per cent	Reference
Java	Toeba poetih Cl. 1	5.6-8.2 (nine SP)	Koolhaas, 1938.	2.7 SP	Koolhaas, 1938.
Puerto Rico	Changi 3.. ..	9.2	Georgi, 1937a.	4.16	Puerto Rico Rept. for 1937. Unpublished.
Tanganyika, coastal Tanganyika, Northern Prov., ca. 5,000 ft.	Amani clone ..	8-11	Unpublished.	4.0	Unpublished.
Nyasaland ..				3.3	Unpublished.
Kenya, 5,400 ft.				4.5	Unpublished.
Malaya	Changi 3 Cl. 2 ..	11.72-13.8 (nine SP)	Georgi and G.L.T., 1940, Table XIV.	5.4 7.63 SP	Unpublished. Georgi and G.L.T., 1940, Table XIV.

It is a noteworthy fact that the proportion of rotenone to total ether extract appears to be on the whole much less variable than the proportion of rotenone in the root. This applies to both the clones recorded by Koolhaas (1938) and to four of the six sets of clonal samples given by Georgi & Gunn Lay Teik (1940, Table XIX). The latter authors concluded that rotenone forms about 45 per cent of ether extract "regardless of the age and spacing". This may be of interest from the point of view of the biochemistry of rotenone.

In weight the variation is very great indeed. In Malaya, Georgi & Gunn Lay Teik (1940) have concluded that there are "wide variations . . . at all ages between the weights of root from individual plants of the same vegetative progeny". Plants of the Amani clone in East Africa occasionally produce very large roots indeed, the "record" being 15½ lb. of fresh root from a single plant grown in rather heavy soil, unmanured, and without irrigation, at Mahezan-gulu (about 2,400 feet above sea level).

A great seasonal variation in rotenone content has been reported from Formosa (Anon., 1939 b), e.g. 12.12 per cent rotenone in July, against 4.48 per cent in February. Nothing of the sort has been recorded elsewhere and it would be interesting to have details of the sampling and statistical technique.

The extreme of variability is reached in the fact that, as reported by Moore (1943), a single root may contain twice as high a percentage of rotenone as another root of the same diameter on the same plant

CLIMATE AND DERRIS

It has been stated (Cahn, 1935) that the climate desirable for derris cultivation has an annual rainfall of 90 to 130 inches, evenly

spaced, "a temperature of 80°F. or over* and a humidity figure of 80 to 90". This is a reflection of the climate prevalent at Singapore and in parts of Java. The Java derris is mostly grown below 500 feet with 100-150 inches of rain a year and "average shade temperature 90°-95°**" (Holman, 1940). In fact, however, derris, including the Changi types of *D. elliptica*, is easy to grow in a wide range of climates; but the effects of climate on yield, toxic content and rate of maturation have not been investigated. Dijkman (1941) thinks that in Java cultivation, above about 2,300 feet is probably not economic.

In this connexion it is important to note that Cahn's statement of the climate desirable for derris may be more applicable to *D. malaccensis* than to *D. elliptica*. Burkhill (1935) accepts the view that *D. malaccensis* is a plant of the Malayan forests, but that *D. elliptica* is not. In the few places in Malaya where the latter may be wild it is found growing over rocks. On the other hand it is abundantly wild in Siam, where the rainfall is lower and much more seasonal. Burkhill suggests that the reason it is so rarely found out of cultivation, and flowers so rarely, in Malaya, may be that the rainfall there is too great.

Maas (1935) quotes statements that *D. elliptica* is widespread as a wild plant in the East Indian archipelago. It is not clear from the statements whether in that area it shows any climatic preferences, but in Java, as in Siam, it appears not to be a typical forest plant, but to flourish and flower freely "where the soil is not too dry", in "bush", on forest edges and river banks. Backer (1911) gives the range of the wild plant as up to 1,000 m. (3,300 ft.) above sea-level.

* As so often, temperature figures are here stated without proper definition. Cahn undoubtedly refers to mean temperatures, Holman to mean maxima.

When considering these facts in relation to commercial derris-growing it is necessary to bear in mind that the selected types and clones that provide the basis of commercial production may be distinguished at least as strongly by physiological and ecological peculiarities as by morphological and chemical, and to that extent such generalizations as those made above, from field observations, may not be relevant. Moreover the climate most favourable to the maintenance of the species in nature is not necessarily the best for high toxicity or high yield of root. With *D. elliptica* Changi 3 grown on well-drained soil in Puerto Rico the conclusion has been formed that the roots lay down tissue in which starch cells predominate during the dry seasons and tissue rich in resin cells when the aerial parts flush at the beginning of the rains (Mayaguez Report for 1939). Later indications are that well-distributed moisture, maintaining constant growth, continually promotes a high proportion of resin cells (Moore & Jones, 1943).

Contrary to this, workers in the Philippines (Silayan 1940 a, 1940 b) believed they had an indication that a "climate with distinct wet and dry seasons" might be conducive to a higher rotenone content. It had been arranged to test a selected strain of *D. elliptica* in areas "representing the four types of climate in the Philippines". Any results obtained are, of course, not available.

The four cases of aberration in rotenone content for the Amani clone shown in Table 2 tend to support the Puerto Rico view. Two of the low-rotenone consignments, those from the Northern Province and from Kenya, are from areas with cool climate, low annual rainfall and long droughts. The climate in which the Nyasaland derris was grown is not known, but was most probably similar.

In Malaya there was little inducement to investigate the effects of climate. The section headed "Variation in toxicity with change in environment" in the paper by Georgi, Greig and Gunn Lay Teik (1938) is concerned solely with differences in soil. There is, however, a very interesting incidental remark by Bunting and Milsum (1930) that *D. elliptica* is "quite amenable" to the climate of Cameron's Highlands, which has temperatures right outside those recommended (see Table 3), and produced there the good yield of about 8 oz. root (air-dry) at 20 months. It may be noted that no subsequent references to derris in the Malayan highlands can be traced; so that, for whatever reason, lowland cultivation was

apparently preferred. It is unfortunate that the toxic content of the root grown in Cameron's Highlands has not been recorded.

The climates of Malaya and also parts of Java are distinguished by being extremely equable, with a high and very well distributed rainfall, as shown in Table 3. The stations I have selected are: Singapore, as the home of the Changi types; Kuala Lumpur as typical of low inland areas; and Cameron's Highlands at about 5,000 feet. The data are derived from the monthly statistics in the *Malayan Agricultural Journal*.

The climates in which most of the East African derris is produced differ rather strikingly from the above. The areas in which most of the plantings have been made fall into three groups: (a) the coastal plain; (b) the East Usambara Mountains and the eastern edge of the West Usambaras, all at about 3,000 feet; (c) the Northern Province of Tanganyika at about 4,500 to 5,500 feet. Temperature data for these areas are deficient and the only stations available are Tanga, Amani and Arusha. Of these, Tanga is not very satisfactory for the present purpose, because the derris on the coastal plain is mostly grown far enough inland for the temperatures to be, in all probability, appreciably higher than the Tanga figures and the rainfall to be lower.

In making these comparisons I was naturally tempted to use climatographs. For the temperatures they would have been satisfactory, since in such tropical areas there is so little variation between years in the mean maximum and mean minimum for any given month. But the high variability of the rainfall introduces a difficulty. If one uses the long-term "floating average" the occurrence of dry periods is smoothed out, especially in the Tanga and Amani climates; while the use of a selected single year or average of two years gives a precision that is fallacious.

As will be seen from Table 3, the East African climates, in which derris has been grown commercially, all differ from the Malayan in being less equable in temperature and with less well-distributed rainfall. The daily as well as the annual range of temperature is greater; and the difference in rainfall distribution becomes still more marked when it is explained that at none of the Malayan stations are any two of the low-rainfall months consecutive, while at the Tanganyika stations, except Amani, as many as five may be.

The differences from the important Malayan areas, typified by Singapore and Kuala

Lumpur, may be summarized for the East African areas as follows:—

- (a) The coastal strip is, if anything, not so hot as the main producing areas of Malaya, and with only two-thirds the rainfall, received much more unevenly. On the Tanganyika coast established derris plants have undergone a drought severe enough to defoliate them.
- (b) The Usambara Mountain derris areas get nearly as much rain as the Malayan, but not so well distributed. The climate is much cooler, by 16–20°F. in cool-season maxima, though only by 3–8° in hot-season. The night temperatures are 9–13° lower.
- (c) The Arusha climate is quite different from the Malayan, with half the total rainfall and with long droughts. The temperatures by day are like those of the Usambara areas, but by night appreciably lower.

On the other hand, Cameron's Highlands, where derris certainly grew well, are cooler

than any of the East African areas, but have much more rain much better distributed.

In East Africa, where the derris is all *D. elliptica* Amani clone:—

- (a) Maturation is certainly slower than elsewhere (*see* section 6).
- (b) Unpublished analyses indicate that there is no consistent difference in rotenone content between derris grown at sea level and at about 3,000 feet, i.e. in temperatures running some 10°F. lower. There is an indication, now being followed up, that derris grown at 4,000 feet and over in climates with low annual rainfall and long droughts tends to be much poorer in rotenone.
- (c) The yields per acre obtained at Amani appear to be higher than anywhere outside East Africa (*see* section 9).

Clearly the above facts offer an interesting field for investigation.

TABLE 3

Country	Approx. altitude in feet	Mean monthly maxima °F.	Mean monthly minima °F.	1938-40		
				Total rainfall (inches)	Number of months with less than 2 in.	Less than 4 and more than 2 in.
Malaya—						
Singapore	S.L.	84.5-87	73.5-77	276	—	6
Kuala Lumpur	S.L.	88-92.5	70.5-73	234	3	2
Cameron's Highlands	5,000	70-73	53-58	299	—	5
Tanganyika—						
Tanga	S.L.	79.5-88.5	67.5-75	168	15	11
Amani (East Usambara)	3,000	68-84.5	57.5-64	240	4	12
Balangai (West Usambara)	4,600	*	*	242	6	14
Mahezangulu (West Usambara)	2,400	*	*	177	10	13
Arusha	4,600	67-87	53-62.5	149	15	11

*Mahezangulu temperatures are probably about the same as Amani, and Balangai about 4°F. lower.

NOTE.—The long-term floating averages of the Malayan stations are rather higher than the above figures would indicate, namely, Singapore 94.99 ins. (64 years); Kuala Lumpur, 94.92 ins. (58 years); Cameron's Highlands, 107.14 ins. (16 years)—*Manual of Rubber Planting*, Kuala Lumpur, 1937.

(To be continued.)

LOOKING ABROAD — LOOKING AROUND — LOOKING AHEAD

REFLECTIONS ON LAND POLICIES WITH SPECIAL REFERENCE TO KENYA PROBLEMS

by Colin Maher

Published by E.A. Standard, Nairobi; Price Sh. 1/25

The review of this booklet has, unfortunately, been delayed and will, therefore, appear in our next issue.

THE GROWING OF MVULE IN UGANDA

By N. V. Brasnett, Conservator of Forests, Uganda Protectorate

(Received for publication on 22nd June, 1944)

The Report on the Botanical, Forestry and Scientific Department (of Uganda) for the year ended 31st March, 1908, stated:—

"By the Governor's direction a timber plantation has been formed in the vicinity of each Station, excepting those of the Nile Province. The two most important timbers of the Protectorate, viz. *Nsambya* (*Markhamia platycalyx*) and *Mvule* (*Chlorophora excelsa*) have been planted. The areas of the plantations vary from 10 to 30 acres, according to the importance of the Station. It is hoped that these plantations will afford an adequate supply of timber for station purposes in years to come."

In the report at 31st March, 1911, it is recorded that:—

"Owing to the very unsatisfactory progress these plantations made, it was suggested to His Excellency the Acting Governor by the Superintendent of Forests that these plantations be abandoned and His Excellency concurred."

The next mention of *Mvule* planting was made in the report at 31st March, 1916—"In the month of August (1915) a site was chosen . . . in Busoga for the purpose of establishing an *Mvule* plantation, ten acres were selected and this area has been cleared and planted with young seedlings of *Mvule*, 6 feet by 6 feet. Although water buck have caused some damage by nibbling off the tops of young plants, the trees are now thriving and doing well." This attempt "was not a success and had to be given up" (1918), and the next followed in 1920, when plots of various species were planted at Entebbe and reported on as follows:—

"The young trees are generally doing very well with the exception of *Mvule* which is badly attacked by a species of *Psyllidae* which causes galls to form on the young growing points and leaves, thus deforming the plants and seriously retarding their growth."

This pest, by then identified as *Phytolyma* sp., was still the subject of complaint in references to the same area made in 1924, and there are now no planted *Mvule* in the Entebbe plantations, unless a few saplings scattered about in the present Eucalypt blocks are relics and not self-sown seedlings, as are similar plants often seen in gum plantations.

By 1930, it was realized that more *Mvule* (Iroko) timber had been cut in Uganda than all other timbers combined and that, though there was a fair amount of natural regeneration, notably in the savanna lands of Busoga and Budama, its sparse distribution made reservation, protection and management difficult. Obviously gazetted Crown forest areas in which existing *Mvule* could be protected from fire and unauthorized cutting and supplies could be replaced and extended, were essential. The attempts made are described below by localities, although chronologically they overlapped and interacted.

BUSOGA

In South Busoga a considerable area of *Mvule* savanna had been cleared of its population by sleeping sickness regulations about 1906 and a Crown Forest 240 square miles in extent was gazetted. This land, at an altitude of nearly 4,000 ft. above sea level, with a rainfall of about 50 inches a year, consisted of a series of low ridges carrying elephant grass (*Pennisetum purpureum*), scattered *Mvule*, *Albizia* spp., *Pseudospondias microcarpa*, *Canarium schweinfurthii*, figs, etc., with patches of denser bush and forest in which *Nsambya* was common, alternating with shallow valleys, swampy in the wet seasons and filled with grasses, sedges and *Acacia campylacantha*. Before 1906 it was heavily populated, produced large crops of bananas (*Musa paradisiaca* varieties) which were the main food of the people, and was reputed to be very fertile. Since 1906 it had had a long rest and in spite of fires, bush had spread and there were good stands of *Mvule*, some old and dead, with a fair sprinkling of saplings, particularly near the shores of Lake Victoria, where Africans attributed them to seed dropped by parrots flying down to the lake to drink.

The management policy was complete fire protection of the more accessible portions of thick bush until they become fire resistant, early controlled burning of the rest, with observation of the progress of natural regeneration under both treatments and intensive artificial establishment of *Mvule* in small blocks.

Between 1930 and 1934 sites in various types of bush and grass savanna were selected; some were cleared and burnt, some patch cultivated, some had lines cut through the bush, and in

them direct sowing and planting of young transplants and stumps (root and shoot cuttings) were tried at various spacings, with and without nurses, in the open and under canopies manipulated to provide various degrees of light intensity. In 1932 investigations into "stone" [1] [3] in Mvule showed that the sap of the species contains a good deal of calcium carbonate and it was suggested that the calcium requirements of the tree might be particularly high. Accordingly marked lines of plants and marked portions of nursery beds were treated with lime to see if this made any appreciable difference to growth or to resistance to gall attack, but no significant results were obtained.

Buck, pig, porcupine, buffalo and elephant were found to be serious pests and neither ditching and fencing of plots or individual guards built round each plant, combined with shooting and laying of poisoned baits gave adequate protection against browsing and uprooting. The individual guards were the best, but were rapidly covered with creepers which unless constantly cleared away, smother the young plants. *Phytolyma lata* [4] [5], the Mvule gall fly, was also a very serious pest and eventually patrols were employed to hand-tend every Mvule once a week. This period was selected after observations had shown that the shortest time after egg laying within which a gall could be detected was three days. At this stage the gall is very small and can be rubbed off the plant with a finger, but is very easy to miss seeing. By nine days galls are very obvious but can still be slit open with a razor-blade without damaging the normal plant tissue, thereby preventing further development of the insect which if undisturbed, would have emerged mature in another twelve days. The fly was found always to be most active and numerous about five or six weeks after the main rainy seasons when Mvule plants should be growing rapidly. The favourite place for egg laying is on the soft tissue at the base of leading and terminal buds. One coppice shoot under observation grew five inches in the 21 days between egg laying and emergence of the fly, so the gall produced was well below the growing point. This probably explains why less damage is done by gall to vigorous growing Mvule than to sickly struggling plants, although the former have far more galls on them because of the greater amount of young tissue produced. Kennedy's [5] observation that cutting off galls in such a way as to cause considerable exudation of sap is harmful, was confirmed, so patrols are instructed to rub off

all galls small enough to be so treated and to slit open the rest without cutting into the stem or leaf. This treatment can of course only be carried out conveniently to include leading shoots as long as the latter are within about nine or ten feet of the ground and can be bent over for inspection, but after this height is reached, the leading shoot is protected to a certain extent by the leaves and branches of the crown from the fly, which appears to like operating fairly near the ground. The primary problem was obviously to get the Mvule through the stage of extreme susceptibility to browsing, gall and creepers up to a height of about ten feet quickly and cheaply. By the middle of 1934, though about 480 acres had been planted in various different ways, it became obvious that this problem was not being solved. In spite of heavy tending expenses the trees were not growing and a number were dying back and shooting again repeatedly. This is apparently a habit of young Mvule at odds with its environment and may be an attempt to build up a root stock strong enough eventually to send up a fast-growing shoot which will establish itself in a good season. Many, however, send up weaker and weaker shoots and finally die. The Mvule planted in the open were up to twelve feet high but were too badly forked and distorted by gall to be likely to become useful trees. Experiments elsewhere had indicated that stumps from two or three years old nursery plants produced the desirable rapid growth in the first few years after planting, so operations were suspended in Busoga while the necessary nursery stock was raised. The existing plantations were allowed to close up to bush in which it was hoped that the Mvule would be protected from buck and gall and eventually struggle through in small numbers, as had been recorded from Nigeria [6].

In 1936 and 1937 sixty acres were planted with large stumps, every one of which shot well, in bays cut in the bush off inspection paths and protected by thorn trash. The bush chosen appeared capable of good height growth and contained numbers of promising young Nsambya. The canopy was selected or adjusted to give as nearly as possible the amount of shade which had been found to be beneficial elsewhere and spacings of 30 ft. by 30 ft. and of 15 ft. by 15 ft. were used. The average growth was 3½ ft. in 12 months and about 6 ft. in 2 years, but there or thereabouts they remained. The trees were spindling and refused to develop proper crowns in spite of weeding, cultivation and canopy reduction. Their leading

shoots were still susceptible to gall and patrolling was expensive in the conditions maintained for protection from game.

In 1938 and 1939 further attempts were made to find suitable sites and small plots of stripplings (stripped nursery saplings) 5 to 6 ft. high were planted out in accordance with the Ivory Coast technique then recently described by Professor Stebbing [7]. By 1940 very little progress had been made and Mr. A. S. Thomas [8], Economic Botanist, examined a number of surface soil samples from various parts of the plantations and bush. He found that where natural regeneration of Mvule had occurred the soil was slightly alkaline, whereas elsewhere it was acid, and that most of the mature Mvule were growing near old termite mounds. He concluded that old house sites with their past accumulation of ashes and refuse, and also termite mounds caused a local increase of bases in the soil which is reflected in the reaction, and that only on such accumulations would Mvule thrive in the Busoga soils. Thomas proposed that sample lines of planted Mvule should be treated with wood ashes and lime respectively to test this theory and also suggested that if large bonfires were made on the spots for new Mvule plants the extra supply of bases might induce more rapid initial growth. These experiments were put in hand but before any results could be observed, sleeping sickness broke out again and the whole Crown forest was closed by medical regulations. The Mvule was left to the bush and it will be very interesting to discover at some future date what proportion succeed in establishing themselves. Experiments elsewhere are showing a very fair proportion of survival, but the earlier results in Busoga were so discouraging that it may well be that soil, or some other imperfectly understood conditions there, will not permit of the same degree of success.

UNDERPLANTING EUCALYPT PLANTATIONS AT TORORO AND LIRA

At the end of 1932 a number of naturally sown Mvule seedlings were noticed in a drained papyrus swamp at Tororo which had been planted with Eucalypts in 1930. In 1933 artificial introduction at 30 ft. by 30 ft. was started, first with seedlings and later with stumps. The area had a light shade 40 ft. to 50 ft. above the ground and the soil and ground water conditions had produced an undergrowth of *Acalypha* spp., *Piper umbellatum* and other herbs. As the plantation was in

a township, game damage was negligible, but the gall fly was present and hand tending, which in the conditions present cost about Sh. 2/40 per acre per annum, had to be carried out. Mvule stumps prepared from two-year-old nursery plants grew about 5 ft. a year for the first five or six years without any signs of check and had straight slender stems adequate for support, regular patterns of light branches and long, pale-green shade-leaves. Similar underplanting was tried in various other Eucalypt plantations to find out the limitations of the method. Some sites were apparently too dry for Mvule to establish themselves with the existing gums and the plants remained stunted, heavily galled and died back periodically.

In drained and planted swamps in Lira the gall fly was absent when underplanting of Mvule was started and exceptionally good results were obtained. In 1939 the first felling of Eucalypts over six year old Mvule took place and although rather more supervision was required than is usual, the damage done was slight. In two years the coppice was above the Mvule again and though height growth of the latter had slowed down considerably, the sapplings are promising. Enumerations carried out in 1943 showed 81 per cent of the original stocking at four to six years old in 90 acres which had received regular attention and an average stocking of 54 per cent over 380 acres, much of which had been neglected since the outbreak of war.

It is now possible to judge what Eucalypt areas are suitable for underplanting and as such areas become available from time to time, they will be stocked with Mvule.

NATIVE ADMINISTRATION AND FOREST DEPARTMENT PLANTING IN LANGO AND ACHOLI

Very valuable information has been gained from Native Administration plantations started by Administrative Officers in Lango, a district which had no Forest Officer before 1938. The practice of establishing supplies of poles for native administrative buildings, etc., began about 1926 and Nsambya (*Markhamia platycalyx*) was found to flourish there. Quite the best Nsambya plantations in Uganda resulted and about 1929 the District Commissioner started to plant Mvule. Koli and Eruti counties were then free from the gall fly and the trees grew rapidly. Unfortunately the early planting was at wide spacings, generally about 30 ft. by 30 ft., in the open, without nurses, so the trees developed large side branches which sometimes became so heavy that they broke

down, tearing large strips off the stems. At ten years old these trees were 35 ft. to 50 ft. high and quite beyond pruning. One area planted in 1929 at 18 ft. by 18 ft. was pruned in 1939, but the wounds were too large to heal and rotted. Another planted at 20 ft. by 20 ft. in 1932 was fortunately filled to 10 ft. by 10 ft. in 1933, and in June, 1940, the trees were 24 ft. to 31 ft. high (average 25 ft.), clean to about 12 ft. with not too heavy branches above and with girths at breast height from 12 inches to 23 inches (average 16 inches). At 11 years they averaged 36 ft. 8 in. in height and 20 inches in girth at breast height.

Four Mvule surviving from a group of five planted 17 ft. apart on Lira golf course to commemorate the signing of peace in 1919, averaged 69½ ft. high and 7¼ ft. girth at breast height when 25 years old.

Mvule being a deciduous species is not suitable for pure plantations unless an evergreen understory can be maintained. Those in Lango were clean-weeded for years and either had bare floors showing evidence of erosion or grass which constituted a fire danger in the dry seasons. Efforts to introduce herbaceous growth in these conditions were not successful, nor could such trees as Nsambya or *Maesopsis* make headway. *Cassia siamea* was established in some but it was too late to have much effect on the shape of the Mvule.

About 1934 the District Commissioner, Lango, started to plant *Cassia siamea* for fuel and in consultation with the Forest Department tried Mvule with it. One such plantation formed in 1935 had an Mvule every 40 ft. in rows 40 ft. apart, with three *Cassia* rows 10 ft. apart in between, the *Cassia* being planted every 5 ft. in the rows. By December, 1943, the best of the Mvule were over 30 ft. high, clean to 20 ft., with a girth at breast height of 17¼ in. In 1940 a number of acre plots of *Cassia* with Mvule at various spacings in them were established and growth in almost all has been remarkable, though it is too early yet to draw any conclusions from them. The mixture is not an ideal one and will be difficult to manage, but is likely to be useful for the provision of "village" timber in conjunction with permanent local fuel supplies.

By the time a Forest Officer was posted to the district some of the Nsambya plantations which had been exploited selectively for poles of various sizes for a number of years, were mainly coppice and had developed into uneven-aged forests with good herbaceous under-stories. Natural Mvule seedlings 1 ft. to 3 ft.

high were found in some of them and one Mvule that is believed to have been planted in 1932 under three-year-old Nsambya, had, in 1939, a clean stem to 30 ft. with a small but adequate crown above. In 1939 some of these Nsambya blocks were under-planted with Mvule which made excellent growth, e.g. 10 ft. in eighteen months from stumps, and several new mixtures of Mvule and Nsambya were tried, both in Lango and in the neighbouring district of Acholi.

One such plot in Acholi was planted with small Nsambya stumps at 3 ft. by 2 ft. with two-year-old Mvule and Mahogany (*Khaya grandifoliola*) stumps alternately at 18 ft. by 6 ft. At one year the Nsambya and Mvule averaged 4 ft. 6 in. high and the Mahogany 3 ft. 9 in. At three and a half years the Mahogany overtopped everything and the Mvule, about 15 ft. high, was below the Nsambya, but not at all suppressed by it.

Judged by the original vegetation the soil of this plot was rather below the average quality for the district, and when tested by Thomas [8] among several other Mvule plots in 1941, it gave a pH reaction of 5.0 by the B.D.H. Universal Indicator, with phosphates 2, potash and calcium 1 each, estimated by Spurway's method on a scale of 0-4. Other Lango and Acholi plots in which Mvule was thriving had pH reactions of 5.0 to 6.5 with phosphates 1 to 3, potash 1 to 3 and calcium 1 to 2. The South Busoga areas of Mvule planting also tested by Thomas, had shown pH 5.5 to 6, phosphates 1, potash 1 to 2 and calcium 1 to 2, while surface soil from near natural regeneration and old Mvule in various districts had pH reactions of 6.5 to 8, phosphates 1 to 3, potash 3 to 4, and calcium 2 to 3. The figures were puzzling and do not appear to tell the full story when compared with the growth of Mvule at the sites tested.

Mvule can obviously be grown with Nsambya both introduced as an understory and planted with it originally and this is useful for small supplies for peasants, but not very helpful for large-scale establishment. Experiments were therefore started in Lango and Acholi to find a cheaper method of timber production in these districts in which Mvule showed so much promise.

Blocks of good savanna containing *Terminalia* (*T. velutina* and other spp.), *Combretum*, *Lonchocarpus*, etc., were obtainable for reservation as Crown forests and plots were established by planting in the savanna, in clear felled savanna with the brushwood burnt hap-

hazard, in savanna with the brushwood piled and burnt on the sites for Mvule, and in ring-barked savanna. The general altitude was about 3,700 ft. above sea level, the annual rainfall 50 inches or a little more and the mean temperatures ranged about 73° F., with relative humidity of the order of 79 per cent in the morning and 48 per cent in the afternoon. Various mixtures of nurse trees, subsidiary species and spacings were tried and by 1943, when 265 acres had been planted and the earliest were four years old, plans were made for planting 160 acres a year in three separate blocks for 100 years. The more expensive treatments involving cutting or ring-barking showed no advantages, in fact the Mvule in the plots so treated was stocky and branched compared with that planted under the savanna, and disintegrating *Terminalia* in the ring-barked plots had caused considerable damage. The important thing appeared to be eradication of grass as early as possible which was done by weeding out grass only, leaving all other growth and establishing a cover as quickly as possible. Many of the Mvule planted in 1939 had attained 20 ft. in height by 1943 and averaged 15 ft. over a sample acre. Striplings 5 ft. to 7 ft. high raised by transplanting four- or five-month-old seedlings to nursery breaks at 2 ft. by 2 ft. spacing for two years, proved to give the best establishment and growth for both species. Sample plots of these averaged 13 ft. high in 2½ years and 16 ft. in 3 years from planting out in their final sites.

The mixture provisionally prescribed in 1943 was 56 Mvule and 56 Mahogany (*Kahya grandifoliola*) per acre planted in double squares (quincunx) of 28 ft. sides, with nurses of *Phyllanthus discoideus*, *Gmelina arborea* and *Harungana madagascariensis*, which last is very useful in suppressing grass. Planted plots need complete fire protection for about three years, after which they are safe and the rest of the areas awaiting planting are to be treated with controlled early burning to reduce grass in them. Costs appear likely to be under £3 an acre for the first year, under £1 for the second and a shilling or two for the third, but can probably be reduced with further practice.

The gall fly was not present at first in these areas but soon appeared, though it is more heavily parasitized than in Busoga. The parasites are Chalcids, *Psyllaephagus phytolymae* and two unnamed ones belonging to the sub-family Tetrastichinae of the family Eulophidae, all recorded from other districts of Uganda as well, and with the named one always the most plentiful. The West African parasite

Aprostocetus roseveari does not occur in Uganda. Hand tending is carried out and has cost from Sh. 2/83 to Sh. 0/52 per acre per annum.

BUNYORO

Quite early in the experimental line and group planting for regeneration of exploited coupes of the Budongo Forest, Mvule stumps were tried. They were badly browsed by bush-buck and duiker [2] but one planted in 1933 and kept under observation was 36 ft. 9 in. high with a girth of 1 ft. 0¼ in. at breast height in May, 1944. Later, when Mahogany (*Kahya anthotheca*) striplings were used and found to reduce tending costs, groups of Mvule striplings, the resulting foliage of which was mostly beyond the reach of buck, were tried. These show less even growth than the Mahogany and different individuals in a group vary considerably, the best being about 15 ft. high in 2½ years. Elephant constitute the most serious danger and gall is present, but in the conditions of scattered forest planting hand tending is not economic.

In some of the *Maesopsis* "gaspies" (hoed plots in canopy gaps seeded naturally or sown broadcast) a few natural Mvule appeared and thrive, so in 1942 trial sowings of Mvule were made. Nine plots were broadcast with *Maesopsis* and Mvule was sown at stakes in April and May. Although there were abnormal droughts in both 1942 and 1943, a few *Maesopsis* and in some plots, a lot of self-sown *Alstonia congensis* and/or *Trema guineensis* survived. At the end of 1942 the Mvule varied from 1 in. to 2 ft. 3 in. high and at the end of 1943 from 5 in. to 5 ft., the average of 18 plants in No. 1 being 3 ft. 4 in. These plots should show whether there is any difference in growth between an undisturbed seedling and a root-pruned transplant.

Between 1935 and 1937 experiments were made in grass glades in the forest. These had a vegetation of elephant grass (*Pennisetum purpureum*) into which *Acanthus arboreus*, *Trema guineensis*, etc., were beginning to encroach in the preliminary stages of succession to forest. Mvule and *Maesopsis* are economic species among the local pioneers and attempts were made to accelerate the succession. *Maesopsis* sown and planted in cleared patches was a complete failure but Mvule stumps planted at 15 ft. by 15 ft. in April, 1935, averaged 3 ft. 4 in. in December. In 1936 they were raided by baboons who pulled up 60 per cent of the plants, apparently under the impression that what was planted by man must be edible.

These were replaced, a further 36 per cent died and were replaced in 1937, when 23 per cent were damaged by buck. In December, 1937, the average height was 4 ft. 4 in. and on account of gall and buck the area was abandoned except for fire protection. The Mvule struggled on, heavily galled, while the *Acanthus* spread and other tree species, notably *Funtumia* but also including *Maesopsis*, appeared. In 1940 some 74 per cent of the Mvule were alive, averaging about 5 ft. high and in 1943 the largest was 23 ft. high with many over 8 ft. They are now growing well and much less subject to gall. In another attempt in an area with less *Acanthus* excellent establishment was followed by growth to only 15 in. in nine months and a further 2 in. in the next two years. This was also abandoned and Mvule are still struggling in it. When a little more knowledge has been gained it may well be that planting a considerable number of Mvule in selected areas and leaving them alone except for fire protection, may result in economic stands in mixture with self-sown species.

A very interesting case of early planting came to light in 1935 in an estate belonging to the C.M.S., originally planted with *Hevea* rubber and later under-planted with coffee. Canon Bowers was good enough to supply the information that the Mvule "were planted in 1920 grown from seed gathered at Kiryandongo in North Bunyoro and sown in nurseries on the estate in the spring of that year. They were badly attacked by gall in the early stages but outgrew the attacks without treatment of any kind. The estate had to be abandoned owing to loss"

In June, 1935, the *shamba* was found to be in a very neglected condition with the rubber trees 45 to 50 ft. high over an undergrowth of coffee and bush to about 12 ft. Eleven Mvule were located near a stream and measured. The height was about 45 ft. with 30 ft. to 35 ft. clean bole and girth at breast height averaged 37½ in (30 in. to 46 in.). In June 1944 they were 55 ft. to 75 ft. high with straight (not necessarily clean) boles of 40 to 55 ft., and an average girth (breast height) of 52 inches (43 in. to 65 in.).

This confirms the ability of Mvule to withstand gall attack and to grow to trees of good shape under high light shade in favourable soil with adequate ground water and good drainage, and suggests a possible use for derelict rubber plantations.

DISCUSSION AND SUMMARY

The attempts at Mvule growing described cannot be dignified by the name of 'research'. There has been no control to isolate the various factors causing failure or success; indeed these factors are still to a great extent unknown or imperfectly understood, and no statistical analysis of results has been carried out. Useful information has, however, been collected and some plantations have resulted which show sufficient promise to justify detailed prescriptions for regular establishment in certain areas.

It has been proved that the *Phytolyma* gall is not an insuperable obstacle, that in regular plantings in which men can move freely, hand tending is very helpful and not expensive, and that when thick cover or the scattered nature of establishment makes such tending difficult, a fair proportion of the Mvule will, in favourable conditions, grow slowly through the stage of susceptibility.

Exactly what constitutes favourable conditions cannot yet be defined, but they have been proved to exist in *Terminalia* savanna in Lango and Acholi, in well drained papyrus swamps planted with Eucalypts, in established Nsambya plantations, in gaps in Mahogany forest and in a *Hevea* rubber plantation near a stream. Light, high shade is certainly favourable.

Mvule seedlings are liable to die back and reshoot and the planting of well developed root stocks reduces this danger. Root and shoot pruned stumps have been successful, but the best results appear to be obtainable from two-year-old nursery plants 5 to 7 ft. high, lifted and planted in the dormant stage without leaves or soft buds, and these are nearly immune from damage by browsing.

Very little is yet known about the silviculture of Mvule after establishment, except that mixture with other species, giving light top shade and/or good side shade produces trees of good height and clean boles, both of which are lacking in the open. In the Budongo Forest one Mvule felled measured 179 feet with 116 feet of clean, unbranched timber, whereas in the Busoga savanna height rarely exceeds 100 ft. and heavy branches or forks usually occur below 40 feet.

Compared with the literature of such species as Teak and Sal very little has been written about the silviculture of the most important hardwood of tropical Africa. If this paper stimulates foresters to dispute its suggestions and to publish their own experience of Mvule growing, it will not have been written in vain.

ACKNOWLEDGMENTS

Besides the annual reports of the Forest Department under its various names and the publications listed below, use has been made of unpublished reports and correspondence from Dr. Eggeling, Messrs. Brown, Cree, Dale, Dawkins, Freeman, Thompson and Webb, and the late Mr. Wright Hill of the Forest Department and from Dr. Taylor and Messrs. Gwynn, Hargreaves and Thomas of the Agricultural Department.

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DYEING WITH MANAGU

By N. Carrick

A find of some interesting-looking berries in a swamp led to tests being made to find out if the plant provided any dye. The berries, which were growing prolifically amongst the drying-out papyrus of a drained section of the swamp are small, black, and juicy, and are not unlike the English black currant in appearance. They have been identified by Mr. Bally of the Coryndon Museum as a kind of native spinach, *Solanum nodiflorum*, the Kikuyu name being Managu.

The first experiment was made with about 6 oz. of the berries. These were boiled in water in an enamel saucepan and produced a delightful violet-coloured liquor. A short length of yarn boiled in the liquor took the colour well. The addition of alum appeared to intensify the colour slightly. The yarn was rinsed and dried in the sun for some hours.

When half a teaspoonful of Magadi soda was added to the liquor in the saucepan, the colour turned bright green. Another length of yarn was boiled in the liquor and after taking the colour well, was rinsed and dried.

Although these two colours, violet and green, did not appear to fade or wash out during the period of the tests, it is reported that they did not prove really fast when tested for a longer period in Nairobi.

As the fresh berries are not always obtainable a stock of dried berries was prepared by spreading them thinly on newspaper in the sunshine during the day and bulking them during the night. The remaining experiments were made with these dried berries.

Dried berries with an alum mordant produced a rather anaemic khaki, which, as that

colour was urgently needed, was very encouraging. The experiment was continued on a larger quantity of wool in the following manner.

Three pounds of dried berries were soaked in water for about four days. When slightly fermented they were boiled in an untinned iron can for two hours, and then strained. This produced a dirty brown liquor. The wool, 4 oz. of three-ply yarn, which had been previously mordanted with 1 oz. of alum, was then entered into the dye bath and boiled for two hours. By this time the liquid was so reduced in quantity that the wool had to be taken out and rinsed, though the colour was barely dark enough. It was, however, a reasonably good tropical khaki.

The next experiment was made with the large proportion of 4 lb. of dried berries to 4 oz. of mordanted wool. The berries were again soaked in water until fermentation had started. They were then boiled in an untinned iron can for a couple of hours and the liquor was strained. The wool was entered and boiled for about three hours. Before the boiling was complete a level tablespoonful of soda was added to give the necessary green tint for a khaki of the British Army type. The wool was rinsed and dried, and the colour was found to be strong and exactly what was required. A long test in the sun appeared to prove it fadeless.

The enormous amount of berries required to achieve the result, 16 oz. of berries to 1 oz. wool, renders the dye unpractical for work on a large scale. For home use, where only a few ounces of wool are dyed at a time, the possibilities are interesting.

POLLEN CONTROL IN VEGETABLE CROPS

By F. Hawkins, Seed Specialist to the Governments of Kenya, Uganda and Tanganyika

(Received for publication on 11th April, 1944)

Even the best haters of busy bureaucratic bodies must agree that relatively small countries which set out to produce quantities of almost every kind of vegetable seed, must adopt a country-wide system of zoning and/or spatially isolating certain seed crops, to prevent indiscriminate crossing. The sugar-beet growers of England evolved a joint and voluntary system of zoning, some years ago, and this was followed by extensive Government schemes which included several other important crops. Plant breeders and commercial seed-growers have realized the importance of isolating different varieties and "strains" of the same species of plant (unless it is thought to be completely self-pollinating), if they wish their stock to breed true to type.

The methods of excluding unwanted pollen vary. For a small number of plants, enclosing the flower heads in fine nets or bags may be all that is necessary, but for larger lots it is sometimes essential to choose a site which is considered to be out of range of pollen which may be borne by wind, insects and other animals, from the nearest flowering plants which are capable of contaminating the stock.

The latter method, referred to as "Spatial isolation of seed crops" has been dealt with in an article under that title, by Gordon Haskell, in *Nature* (Vol. 152, No. 3864 of 20 Nov. 43). This article is a useful survey of recent investigations to determine safe isolation distances for vegetable-seed crops in Great Britain.

Can we, in East Africa, follow the recommendations which are the outcome of research in Great Britain, and confidently expect similar results? To what extent do our climate, topography and fauna affect the movement and viability of pollen, as compared with the very different conditions in Great Britain? We shall not be in a position to answer these questions until investigations have been conducted in East Africa, on similar lines to those in Great Britain and in other countries. In the meantime, it would profit all farmers, gardeners and seed-growers in East Africa to study the data relating to spatial isolation observed in Great Britain, but to plant at greater distances, wherever possible, to allow for unknown local factors which may be included in the general term of "pollen-carrying agents".

In Mr. Haskell's article distances are variously referred to in feet, yards, rods,

furlongs and miles. For the convenience of readers I have converted these into the more commonly understood yards, miles and fractions of miles, in the following brief extracts from his article.

Cabbages, etc.

"Bees are the chief agents of dispersing pollen of *Brassica oleracea* plants, and wind also carries the pollen of kale and kohlrabi. This necessitates keeping crops of any two members of the same *Brassica* group at a considerable distance apart. A spatial isolation of two miles is common, and sometimes only one mile for cabbages and kale. Recent experiments at the John Innes Horticultural Institution indicate that under natural conditions no crossing, or perhaps slight, occurs beyond 28-yard intervals between radish plots. The usual isolation is not less than 220 yards. Tedin (Sweden) . . . found that at 27 yards between crops of turnip, he obtained 1 per cent contamination. . ."

At greater distances the contamination was not perceptibly less, this fact being attributed to wind and long-flying insects.

Peas and Beans

"With the exception of the broad bean, the Leguminosae do not require large isolation distances."

Broad beans have been observed to outcross to the extent of 7 per cent in the field. Evidence of the correct spatial isolation is not available; I would suggest that broad-bean varieties should be planted at least 200 yards apart, but I cannot guarantee that this is sufficient. Soybean varieties cross between alternate rows at the rate of only 0.16 per cent. French beans at 9 yards apart cross at the rate of about 2.63 per cent between varieties. Peas are considered self-fertilizing, but a space of 220 yards between varieties assures complete elimination of cross-pollination. (The above data regarding French beans may be of special interest to the growers in the Arusha area. A 15- or 20-yard strip of maize planted between bean varieties would cut down that 2.63 per cent crossing which probably occurs along the edges of adjoining varieties.)

Carrot, Parsnip, etc.

"Investigations on outcrossing among members of the Umbelliferae lag behind those of other groups. It is customary to allow half

a mile between different varieties of carrots, but there seem to be no definite figures available for other umbelliferous crops. Parsnip varieties are usually isolated from each other although pollination within the umbel seems to be the rule; it is also customary to isolate celery and parsley varieties. It is therefore surprising to find so little evidence on spatial isolation of these important crops, which include herbs of economic importance such as dill, fennel, carraway and anise."

Cucurbits

"Cucumbers under field conditions undergo 65-70 per cent natural cross-pollination."

Isolation by at least 220 yards is necessary between varieties. (Note the innumerable gradations of types of cucurbits grown by the natives at Kampala, and other places, probably due to unrestricted crossing.) There is little information available regarding distances for isolating marrows.

Lettuce

"Thompson, working in America, grew lettuce plants side by side without protection from insect visitors. He placed the plants just far enough apart so that the lateral branches of the seed stalks did not touch. Under these conditions there was 1.33 to 6.22 per cent out-crossing. Under normal field conditions, therefore, the value would be much less."

Some British growers of lettuce seed make a practice of *not* isolating lettuce varieties. It would appear, from the above, that isolation of some 20 yards would ensure complete freedom from contamination, yet, how conflicting is the advice one reads! For instance, in the *Queensland Agricultural Journal*, dated 1 Aug. 43, H. Barnes states that "... lettuce plants readily cross-pollinate ... only one variety should be grown at a time." Cox and Starr, in *Seed Production and Marketing* state that "... little crossing normally takes place in the field. However, in the production of choice seed stocks, it is necessary to use methods for the protection of the blossoms from possible contamination."

Tomato

"Although the tomato flower is a splendid example of a self-pollinating floral mechanism, even this vegetable is not immune from a small amount of outside contamination. Under field conditions there is a 2-4 per cent contamination between rows."

Eight yards is considered to be a sufficient distance between varieties to reduce contamination to a negligible amount. Paschenko suggests that thrips and not wind are the responsible transmitting agents.

Beet

"The ordinary beet is wind-pollinated, although pollination by insects is also possible."

Wind may carry beet pollen to a distance of over two miles, but there is usually little contamination over 550 yards.

Onion and Leek

"All varieties of onions intercross, so that it is necessary to give a spacial isolation of 250 yards between plots. Insects normally carry out pollination although wind can transmit onion pollen. ... Similarly it is customary to give leeks an isolation distance of 250 yards."

Maize

Wind and gravity are the chief agents for disseminating the pollen. Canadian growers usually isolate by at least one mile between varieties, whilst the U.S.A. legal minimum distance is 220 yards.

SUMMING UP

Pollen-carrying Agents include wind, gravitation, insects, birds and larger animals, including man himself when handling or brushing past flowering plants as he goes from field to field.

Pollen Controls may be in the form of hedges or belts of trees, or hills, or merely sufficient space between the different varieties. For a few plants it is sometimes easier to cover the flowers with muslin bags. Wild plants within pollen-reach and weeds on the farm should be studied and removed if they are of a nature to contaminate the stock. Alternatively, plant the stock in a better site.

Information from Growers, gardeners and research workers, as a result of their investigations of the factors peculiarly affecting pollen distribution in the tropics, would be welcomed by me. Would they kindly write to the Seed Specialist, Seed Station, Turi, Kenya. However brief or inconclusive such observations may seem to the originators, they may well prove, in the aggregate, of considerable value to those of us who are aiming to produce better seeds in East Africa.

HAND SPINNING AND WEAVING IN NYANZA PROVINCE, KENYA

By Mrs. D. Gregory Smith

A year ago the crafts of spinning and weaving were very nearly unknown in the Nyanza Province. A little spindling had been taught by one or two public-spirited women in their very limited spare time, but a wheel and a loom were still the "unknown quantity".

During a rather hurried tour of the Province early in July, I made a point of finding out how the craft was being received by the Africans. Everywhere it was the same story—"we like this work—we want to learn more". At Mumias I was told the little children make themselves a spindle with a lump of clay on the end of a stick, pick up the waste bits of wool, teach themselves to spin a thread and then take it to the Sisters at the Convent saying "now you see we can spin let us join your class". Other Missions tell me they have had to forbid the girls taking their spindles to class, and that every available moment between other work is given to spindling.

In Kitosh country I saw a class run by an African woman, her classroom a shady tree, the ages of her pupils ranging from tiny children to elderly matrons. Every kind of home-made spindle was being used, and the delight on one "granny's" face was good to see. As their Instructress pointed out, "in the past very few old women and children had anything to keep them warm. Now they are *ferai sana sana*—they can all make themselves a warm sweater".

Then there are the more educated and "moneyed" Africans. They are the most enthusiastic of all, and show their enthusiasm in practical ways. Driving along the road from Luanda to Yala my eye was caught by a large board on which was written "Hand Spinning and Weaving Centre", and on closer inspection I saw the nearly completed school, women's dormitory, kitchen and lavatory well built with neat grass roofs. This place has been built by an African whose wife I trained last year at the Kericho Centre—his own money and his own enterprise, and to my mind symbolic of

what this new craft means to the thinking African. In this man's own words: "we like this work, we see it is good". I asked: "But what about after the war when you can buy blankets again?" "Even then" was his answer "we will do this work *because we like it*, and because we know that we can make for ourselves much better things than we can ever buy". Time alone can prove that point, but meanwhile Africans give us proof after proof of their liking and aptitude for this work.

The Main Instruction Centre, financed by Government is at Kericho while two other Centres, the one near Luanda and another at Kimilili, Kitosh, are run entirely by Africans the instruction being given by women who were trained at the Kericho Centre. Local Native Councils have been asked to take over the financing of these two African Centres; and also to help by providing wheels, looms and a small salary to trained Africans, to missions and schools which are willing to co-operate with teaching and supervision. In this way it is hoped to put free instruction and facilities for buying wool in small quantities within the reach of all Africans, until such time as the craft is so well spread that the need for these widely scattered Instruction Centres will no longer be felt.

An Arts and Crafts Show for the Nyanza Province was held in Kisumu on 15th July and the evidence shown of the growth of the craft was described by the Provincial Commissioner as "remarkable". Blankets, sweaters, scarves, socks, coats and children's woollies came from every corner of the Province.

Much credit must be given for this rapid expansion of the craft not only to Government for the financing of the Main Centre at Kericho, but also to the Provincial Commissioner, all District Commissioners, the Inspector of Schools and the European staff of missions and schools. Without their generous co-operation the work would never have gone forward the way it has.

EMERGENCY FOOD PRODUCTION IN ZANZIBAR

By F. B. Wilson, District Agricultural Officer, Zanzibar

(Received for publication on 23rd May, 1944)

Zanzibar has, for many years, been dependent upon imported foodstuffs to supply the main requirements of her population. The expansion of the clove industry, dating from last century, together with that of copra, led to a great reduction in subsistence farming and an ever increasing dependence upon a cash economy and the importation of food. Thus, practically all the best land is now planted to cloves and coco-nuts and, as both these crops require considerable labour, the people have become dependent upon cash wages to buy their food and other necessities of life. Only in years of poor clove harvests, when there was little money in circulation, was there any marked increase in the planting of foodcrops—principally cassava. Thereafter, when work was again offering in the plantations, food planting was abandoned in favour of cash wages and the purchase of cheap imported rice and other foodstuffs. So strongly implanted has the desire to earn money become that, when a good clove harvest has ripened following a lean period, many people have been known to abandon their half-grown paddy crops to go off to pick cloves. Those were the days when imported rice could be purchased for Sh. 15 a bag! Times have undergone a marked change since then!

Rice from Burma was one of the principal food imports. The annual import of this commodity alone averaged over 140 lb. per head of the population during pre-war years. It will therefore readily be appreciated that the fall of Burma set an urgent and difficult problem before the Zanzibar Government. But this was not all. Large supplies of grains and pulses had also been obtained from territories of the East African mainland which, by 1942, were finding difficulties in supplying their own internal requirements. In the early months of 1942, therefore, Zanzibar was faced with the problem of attaining the utmost degree of self-sufficiency as rapidly as possible. People had, in fact, been encouraged to grow more food ever since the outbreak of war, but progress had been limited so long as imported supplies of food were available. Thus, it may be assumed, that the campaign started "from scratch" at the beginning of 1942.

The methods by which this problem was tackled and the results which have attended the "Plant More Food" campaign in Zanzibar form the subject of this article. In many ways the task was one of particular interest because,

as has already been observed, the majority of country people, and particularly the younger generation, had virtually forgotten the meaning of subsistence agriculture. Years of cheap and assured food supplies had inculcated the notion that nothing—not even a war—could prevent a benevolent government from seeing that adequate foodstuffs for all were delivered regularly to the local shop. For many, disillusionment finally came in the shape of decreasing supplies in the shops and markets accompanied by a general rise in prices. These people have now all taken up the hoe. They are providing for their own and their families full requirements of staple food. They are doing more: they are making a substantial contribution towards the feeding of the 60,000 people in Zanzibar town.

The work of the campaign now to be described was essentially a "combined operation". There has existed throughout the very closest co-operation between the two principal departments concerned: the Administrative and Agricultural Departments, whilst a number of other Government Departments have given their assistance by way of propaganda, the loan of staff, and survey work. Policy and plans were worked out by senior officers in consultation. These were then carried out in the field under a single direction. All worked for a common objective during the period of any particular campaign and the same methods were employed in the various districts. Such co-ordination and co-operation has been fundamental to whatever success has been achieved and the writer wishes therefore to emphasize at the outset, that he is describing the work of a large number of officers and assistants.

Certain legislative action was necessary to endow Government officers with authority and powers to put the agricultural programme into effect. All the orders have been promulgated under the Defence (Land Requisition and Personal Services) Regulations of 1942, with certain amendments in 1943. The original regulations provided for the requisition of any land required for food crop planting and for individual cultivation orders to adult males between the ages of 18 and 45 years. Those who could prove that they were in full-time employment were exempted in the original regulations. Later, provision was made for the registration of all adult males both in Zanzibar town and the districts. Finally, the stage has now been reached when crop planting orders

of general application to specified areas are published and carried into effect.

These regulations provided for suitable penalties in cases of conviction for failure to comply with an order. Prison sentences were served at the agricultural prison camp at Langoni so that a double purpose was therein achieved: a prison sentence was awarded the idler, and he served this sentence in well-organized agricultural work which fitted him to carry out his planting orders all the better upon his release. There have been a number of convictions under these regulations, especially when they were first introduced, but it must be emphasized that their proportion to the number of orders issued is exceedingly low. In fact, the summary prosecution of the habitual idler has proved all that was necessary and the campaign, in general, has been carried through with the full approval and co-operation of the large majority of the people themselves.

The success of the various planting drives has, in all cases, depended very largely upon effective propaganda and application of the published orders in the districts. It will readily be appreciated that, in a country such as Zanzibar which lacks any form of tribal structure, the mere publication of planting orders will achieve no more significant results than, for example, the instructions of King Canute to the oncoming tide. The full quota of work is not carried out unless there is effective instruction and supervision by those in authority. This proved to be particularly true in the early stages of the campaign when few appreciated the benefits they would derive from growing their own crops and quite a number feared that they were really being made to plant crops which would ultimately be requisitioned by Government. Experience has shown that the initial campaign for the planting of any particular crop was by far the most difficult and that subsequent planting orders for the same crop were carried out with less supervision or, in certain cases, without any further need for anything more than encouragement.

The food-planting campaign of 1942 was started early in that year with an intensive propaganda drive throughout the districts accompanied by the issue of individual cultivation orders where this was considered necessary. In effect, the campaign aimed at encouraging the industrious and compelling the idle, all to make the fullest possible provision for themselves by planting up food crops. The principal crops upon which the attention was concentrated were cassava, rice and sweet

potatoes. The issue of individual orders depended upon seeking out those people who were making no provision for themselves, selecting and marking out suitable pieces of land, and issuing written orders to cultivate and plant within a given period. Later, these plots were checked and those who grossly neglected the orders were prosecuted. The principal type recruited in this way for cultivation was the loungee at the numerous roadside coffee-shops and other such public rendezvous. It is not difficult to appreciate that ways and means of avoiding an awkward interview with the cultivation controller were soon invented! But, the initial drive conducted on these lines served its main purpose of getting everyone started on some kind of food-crop planting.

There still remained, however, one important aspect which had not been touched: the town population. Zanzibar town, with its population of some 60,000 whose livelihood in normal times is mainly dependent upon trade and shipping, contained many who were unemployed or whose income had been seriously curtailed by changed circumstances resulting from a world war. It was felt that every endeavour should be made to encourage townspeople who were not tied to the town by regular employment to move out into the districts and grow their own food. Others, who lived in town but had not full-time employment should be made to cultivate in the town environs to provide for part of their maintenance.

Accordingly, in May and June, 1942, the whole adult male population of Zanzibar town was registered. As each person came up before the registrar he was interrogated as to his occupation and means of livelihood. If he proved to be unemployed or was not in full-time employment, he was issued with an order to appear before a cultivation controller at a rendezvous in one of the town environs. Here he was issued with a marked half-acre plot and arrangements made for the supply, without cost, of suitable planting material and seeds. A scheme was also inaugurated by which anyone not possessing a hoe or other necessary implement, could work for three days or so and thus earn the price of a Government *jembe*, sold at Sh. 2 each. In this way everything was provided for the cultivation of hundreds of half-acre plots within four miles of the town and it merely remained for the plot holder to set to work.

In the manner described above some 2,000 unemployed or casual workers were issued with plots in the space of two months and within

a short period 1,400 acres of land within a radius of about three miles of the town had been planted to crops, principally cassava. Large quantities of plant material, of the best types, were delivered at scheduled points to the town cultivators, who sometimes congregated in hundred to receive each a large bundle of cassava stems from the Kizimbani Experiment Station. Transport was provided by 2-ton Public Works Department lorries and it is estimated that 90 tons of cuttings were transported and issued to town cultivators within the first six months. Some prosecutions were necessary at the outset, but the ultimate popularity of the scheme was amply demonstrated in the second season when many who had cultivated their half-acre to comply with a Government order, themselves came forward and begged for the issue of a second half-acre which they proceeded to plant of their own accord. It is noteworthy, too, that during this period many people, particularly young men, decided that it was profitless to remain in town and returned to their country homes to cultivate.

There is no doubt that the period of some three months spent in concentrating upon the town population also proved most effective in stimulating effort in the districts. It was convincing proof, even to the more sceptical, that Government meant business and wherever one travelled there was ample evidence that people had commenced to plant food crops in earnest. There was, however, no means whereby the work of the whole community could be assessed accurately nor had the stage been reached when it was possible to issue cultivation orders of general application. These necessities led naturally to the next development which was the general registration of the country people.

Registration of the rural districts was commenced in November, 1942, in connexion with the rice-planting campaign. Registers were compiled of all adult males in each *shehia*, which is the smallest political unit in the country (usually a population of 500 to 2,000). The gathering together of the people for registration provided an excellent opportunity for further propaganda and an explanation of the rice-planting order. The registers themselves contain information never previously gathered which will be of great value in later development planning. Each person was issued with a registration card with space provided for endorsement by field recorders as each different crop is planted and inspected. For the purpose of this inspection cultivators in each area were instructed to await the field recorders on their

plots on a given day. In this way it was possible to inspect, measure, and record the planting work of up to five hundred cultivators per day which represented a great advance upon the examination of odd individual plots as had been done previously. It was also possible to prepare more accurate crop forecasts in replacement of previous arbitrary estimates. The registration card has proved of great value and has since been used in the distribution of rationed commodities and for recruiting and organizing clove harvesting labour.

The original registration of the rice areas and checking of plots were carried out by a mobile field unit assisted by officers of the Administration. This mobile unit consisted of the District Agricultural Officer, one Assistant Agricultural Officer and six to eight field recorders. It moved from place to place, camping in temporary rest camps. As each individual had his plot inspected his card was endorsed and all particulars of the work done were entered in the register. In this way it was possible to single out every individual for inspection and those who had previously relied upon making themselves scarce at such times now had their work inspected. This method proved invaluable and resulted in effective control of the whole campaign.

The final stage has now been reached when the coming year's programme has been planned, discussed and approved by Government and it is only necessary to schedule each crop, the area to be planted within a given time, and the places to which the order refers, to keep the whole programme in operation. The Mudirs (Arab administrative officers) now have a year's programme before them which they can discuss with and explain to their *Shehas* (village headmen). Meantime the agricultural field staff proceeded on their tours inspecting the crop-planting, advising, and reporting progress from the different areas. Many expressions of satisfaction at the Government's programme and methods have come spontaneously from the people themselves.

Experience has proved that by far the most effective results have come from concentrating upon a single project at any one time. Thus, during the course of the year there are the rice campaign, the cassava drive, the sweet potato planting campaign, and that for the planting of pulses. By concentrating upon one crop at a time it is possible to focus the attention of everyone upon the particular task in hand and the whole of the propaganda and advisory services operate on a single agreed plan. Thus, even the remotest country dweller is made

aware of the current planting order and knows exactly what is expected of him within a given period. This does not mean that other crops are not planted during any particular period, but that Government propaganda is concentrated upon the most important in order to achieve maximum planting at the right time. This is important, amongst other reasons, because the average person cultivating food at present is not expert in his knowledge of crops, times, and seasons.

The paragraphs which follow describe briefly the various campaigns conducted to date.

Rice.—Diminishing grain reserves and uncertainty as to future supplies from the East African mainland made it essential to put under cultivation the maximum possible area of rice in the 1942-43 season. In Zanzibar, this crop is grown principally on large open plains in the long rains. Preliminary cultivation is started in November and the crop harvested the following June or July.

The rice campaign was commenced at the beginning of November, 1942, with the publication of an order which in effect made it compulsory for every adult male residing within scheduled areas, and who is not otherwise in full-time employment, to cultivate and plant not less than half an acre of rice. Simultaneously, the mobile field unit assisted by the Administration commenced the registration of the rural male population, explaining the orders, and making arrangements for the systematic inspection of individual rice plots. A survey gang marked out half-acre plots for those who were unable to find their own. Between November and February every area where rice could possibly be grown was visited and the planting of the crop organized. Some 16,000 cultivators were issued with orders in Zanzibar Island and of these 12,600 had their plots inspected and measured at least once in the course of the planting period. Similar work was carried out in Pemba, where the crop is generally about one month later, and in Pemba some 28,000 cultivators of rice were registered. Altogether 30½ tons of seed were distributed, mostly by sale, in addition to the 28 nurseries prepared and planted for the issue of free seedlings in the different areas. Some small drainage schemes were also carried out with the co-operation of local cultivators.

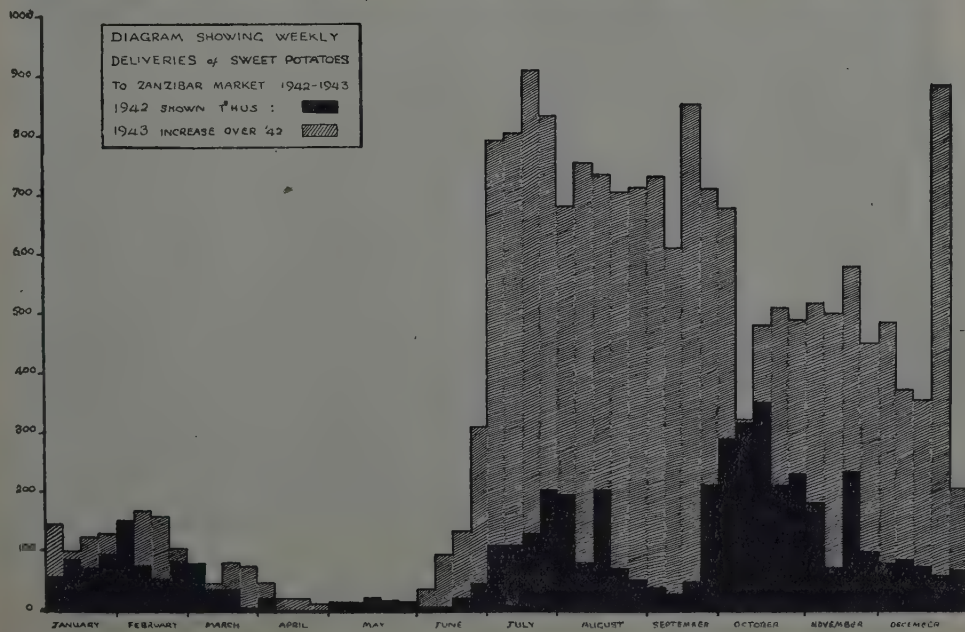
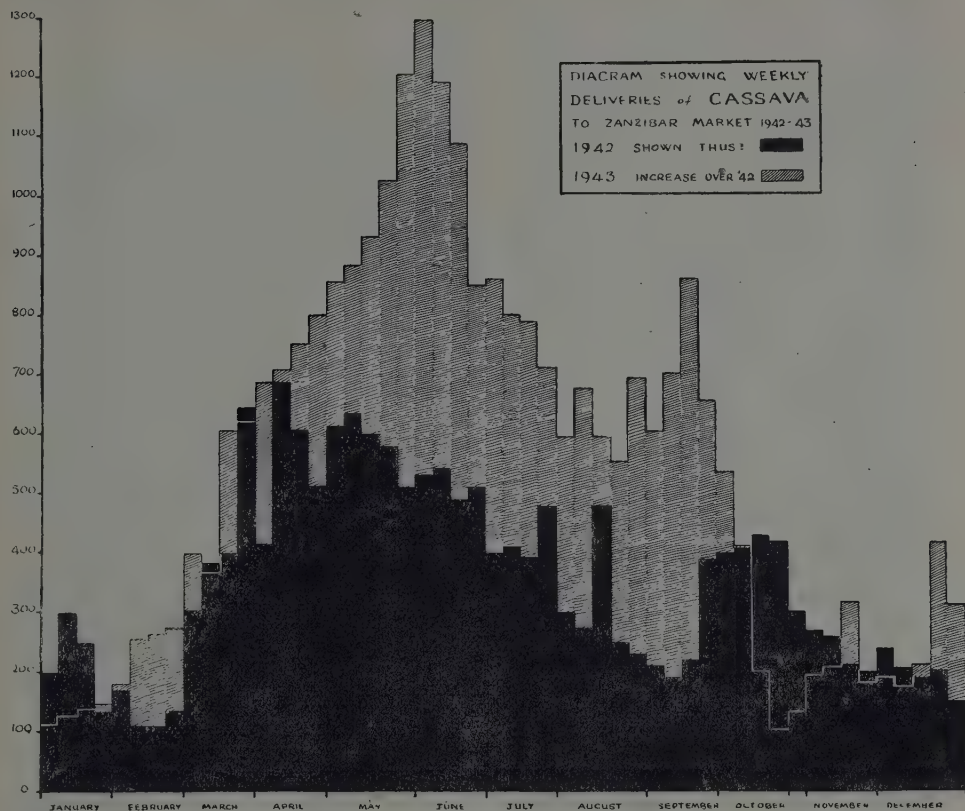
A very dry period throughout January and early February caused seedling casualties, but the rains broke unexpectedly early with the result that all areas were carrying a well-established crop by the end of March. Commencing in June, a survey of the harvest was

undertaken, in conjunction with the staff of the Kizimbani Experiment Station. Some 5,600 random samples each one yard square were reaped in the different areas and threshed. It was found that the mean yield for the crop in Zanzibar Island was 1,500 lb. and for Pemba 1,363 lb. of dry paddy per acre which, considering the variability of sites and the fact that many of the cultivators were novices, must be considered satisfactory. In the previous season (1942) it was estimated that the rice crop in Zanzibar Island amounted to, approximately, 2,500 acres. During the subsequent campaign, commencing in November of that year, the 1943 crop was, by March, known to exceed 10,000 acres. Although there would, in any case, have been a substantial increase by the spontaneous effort of the people themselves, it is certain that a carefully organized campaign in which field staff moved about the districts throughout the growing period of the crop, contributed largely to this result. A similar expansion was recorded for Pemba Island.

Fortunately most people harvested sufficient paddy to maintain themselves and their families in grain for a number of months. The fruits of their labour have been sufficiently encouraging to justify the belief that in the coming season of 1944 most of last season's cultivators will grow at least as large an area without further orders. The crop was not sufficient to allow of any marketable surplus for the feeding of the town population, which still depends upon imported grains supplemented by locally-grown ground crops.

Other Grains.—Both maize and sorghum are grown in substantial quantity in the coral out-crop areas of Zanzibar (*wanda*). Maize is principally grown in the short rains towards the end of the year and sorghum in the long rains of March to May. The people who dwell in these areas are naturally industrious and needed little further encouragement for the extension of their grain areas other than supplies of seed which were duly arranged. The crops have been moderate. Thus, the rural population has, in 1943, provided very largely for its total maintenance in grain foods; those who dwell in the rice areas by growing this crop, whilst the coral dwellers have grown maize and sorghum.

Cassava.—This crop is regarded in Zanzibar as the principal starchy food when rice and other grains are scarce. It thrives in most situations, and yields of up to 11 tons of roots per acre have been recorded. It was, therefore, natural that right from the onset of the campaign cassava should be looked upon as



the most important "stand-by" to be planted in quantity.

The 1942 planting drive aimed at one acre of cassava per adult male in the districts. Examination of several thousand individual plots towards the end of the year showed that in a few areas this had been attained but in the majority the average cassava area was about half an acre per head. The most important planting period is just after the end of the long rains and during the subsequent cool and showery weather (May to August). This is, therefore, the time when a special cassava campaign is launched each year. The crop matures early in the following year. A protracted hot dry spell at the end of 1942 and early 1943 greatly retarded the development of the crop, so that from March to June of this year prices of raw and dry cassava were unusually high. Nothing could have given a greater impetus to this year's planting programme. The man who grew half an acre last year increased his plot to an acre, whilst those who grow a surplus for sale have planted up to two and three acres. Very large quantities of virus-free planting material of the best variety "Msitu" have been issued from the Kizimbani Experiment Station during the campaign.

Statistics exist for all quantities of produce passing through the Zanzibar town market and whilst these do not represent the whole of the produce coming into town, they are considered to give a good indication of the general supply position from time to time. The diagram shows the deliveries of raw cassava to the Zanzibar town market, week by week, for 1942 and 1943. It is clear from the diagram that the 1943 production was nearly double that for 1942. The results of the 1943 campaign will not, of course, be visible until well on in 1944 but, judging by the actual amount planted there should be another very substantial increment. A point of interest in the diagram is that the bulk of cassava is produced in the first half of the year and there is a steady decline after the end of June. This will be referred to when sweet potatoes are discussed.

It is impossible to overestimate the value of cassava as a bulk starchy food in its contribution to the Zanzibar food campaign. During the course of the two years under review both the short rain periods have partially or totally failed. At the end of 1942 the dry-area maize crop was small, at the end of 1943 the sowings had not even germinated. And yet the food position was reasonably assured in the country owing to the large areas of cassava which, although retarded in growth, had withstood the

drought. The protein deficiency of this food has partly been made good by consumption of fish, coco-nut products, and some pulses.

Sweet Potato.—This crop has been referred to as the natural complement of cassava. Being a cool season crop, its period of maximum production in Zanzibar is from July to December and in this way it can be used to maintain the supply of bulk food when the production of cassava is diminishing.

It was not possible, in 1942, to effect an immediate and substantial increase in sweet potato production for the very simple reason that supplies of planting material were not available. Owing to the fact that hot-weather plantings of this crop give very little or no yield, the average cultivator makes no further planting when he harvests the last of his crop in December or January. The discarded vines die in the dry hot weather and no one worries about sweet potatoes until the next planting season which usually starts in May. Then, to everyone's surprise, there is an acute shortage of plant material! This shortage happened every year and, in fact, the rate of increase of the existing meagre supply from May onwards was such that, in the past, the planting of sweet potatoes only assumed large proportions about the month of August or September when the best of the season had passed.

The main task, therefore, in 1942 was to build up a reserve of plant material. This was effected by planting and maintaining sweet potato beds all along the roadsides. The Zanzibar roads have a ditch for drainage on each side and the soil from this drain is thrown up to form a bank on the side away from the road. These banks were levelled out making a bed six feet wide and, for each cultivator, 50 yards long, on each side of the road. Over 80 miles of roadside were thus planted by the end of 1942. Each cultivator was allowed to harvest the crop of his 50-yard stretch but was under obligation to replant and maintain his bed. These beds stood the dry period of November, 1942, to February, 1943, remarkably well.

By early 1943 the stage was set, and, as a coincidence, the need for a rapidly maturing bulk crop suddenly became urgent with the prohibition of all exports of food from Tanganyika Territory. In Zanzibar, every adult male living outside the town area was ordered to plant one-eighth of an acre of sweet potatoes by 31st March. This order was, in some ways, revolutionary as most people do not begin to plant sweet potatoes until after the heavy rains (May-June). In spite of protests that it was too early to plant sweet potatoes, the order was

insisted upon in all areas and, with the help of useful showers, a large acreage of this crop had been established by the closing date of the order.

The results of the campaign are best illustrated by the diagram. During July, August, and September the crop was about 600 per cent more than that for the same period during 1942. What is more, the early drive resulted in the production of such a mass of planting material by the cool season that everyone continued to plant and the supply of potatoes was maintained right into 1944 without the necessity for issuing any further orders or instructions. Incidentally, there was a heavy clove crop during the latter half of 1943 and sweet potatoes were largely employed in feeding pickers. Thus, the diagram which shows deliveries to the town market, would, it is believed, have presented an even more favourable picture had it not been for the fact that several thousands left town to harvest cloves and the sweet potatoes were partly diverted from the town market to the clove areas.

The sweet potato campaign was probably the most successful of all the planting drives and there is little doubt that those who have been convinced of the value of this crop by the returns they obtained in 1943 will not need much encouragement to induce them to similar efforts in 1944. The success of the campaign is attributed to: (a) The accumulation of adequate planting material. (b) Good timing for the earliest planting which was accompanied by favourable weather. (c) The use of every possible agency; posters, meetings and verbal orders to bring the campaign before everyone at the same time. In the case of the drier east and south coast areas when plant material was scarce, loads of planting material amounting to about three million cuttings were dispatched from the Kizimbani Experiment Station and other reserve areas.

Pulses.—In normal times the cultivation of pulses in Zanzibar is limited to small areas of Pigeon Pea on the coral wanda and a limited quantity of gram (*Choroko*), also grown on the coral. The pre-war import of approximately 2,000 tons a year of pulses came from the East African mainland. With the closing of this important source of supply it became imperative to further the cultivation of pulse crops to counteract a serious protein deficiency in the local diet.

Apart from the encouragement of further pulse planting on the coral country it was obvious that the rice areas presented a very favourable place for the cultivation of certain

pulses as an off-season crop. In the south of Zanzibar is a very fertile rice valley where a pulse rotation has been successfully practised by the people for generations and it was considered that an extension of this rotation to other areas would have distinctly beneficial effects both in producing an additional crop and in improving the rice lands. An order was therefore issued at the time of the rice harvest in 1943 that every rice cultivator was to plant not less than half an acre of his rice land to pulses, *kunde* (beans) or *choroko* (gram).

To most people this instruction was an innovation. They were by no means certain that they would reap a crop, and it must be admitted that considerable difficulties were encountered in getting the general planting of pulses carried out. It was therefore decided to concentrate field staff in certain suitable areas to supervise the work. It was hoped that the benefits of planting this crop would be sufficiently obvious to the cultivators themselves to result in a general planting by all next season. This scheme was well rewarded, in so far as most of those who planted *kunde* and *choroko* on their stubbles in good time reaped satisfactory crops. Subsequently, they have observed the enormous benefit in the ease with which they prepared their land for the following rice planting and the reduction in the weed population as compared with the old system whereby their plots were abandoned after harvest to become covered with a mass of grass and weeds which, even when cleared, left millions of seeds in the soil to germinate and compete with the next rice crop. Some 50 tons of pulse seed were sold to cultivators for this campaign and, although it was not so universally successful as the other campaigns which have been mentioned, it is considered that the results demonstrated to the cultivators will greatly assist the 1944 pulse-planting drive.

Bananas and Plantains.—No special drive has been conducted for the increased planting of bananas but their importance in helping out the food situation is illustrated by the fact that approximately 1,172 tons were sold in the town market in 1943. That was 110 tons more than for 1942. Suckers of good varieties were distributed in some quantity by the Department of Agriculture, but in the main the expansion has been carried out by the people themselves. The people of Zanzibar are not normally plantain eaters and it is good to see an increase in the production of this nutritious food.

When production campaigns for the increased planting of crops for export are undertaken, it is comparatively easy to assess their

effectiveness and results by readily available figures of markets and export centres. With food crops for internal consumption there is no such concise and accurate method by which results can be judged. Certain statistics from the Zanzibar market have been quoted but this market, after all, deals principally with the surplus of local produce after the rural communities have satisfied their own requirements. We have, therefore, to content ourselves with the following broad conclusions: there has been no famine in any part of the Protectorate; the rural people have now made themselves virtually independent of external supplies of staple food; in addition, the country districts are making a substantial contribution in locally-grown foods towards the support of the town population. A useful criterion of the amount of additional food grown is provided by the import statistics. In the case of grains, flour, and pulses, the total figures for pre-war (average of 1937-1939) and those for 1943 show a difference of approximately 15,000 tons. This difference has been wholly made up by locally-grown foodstuffs although no one will pretend that everybody has enjoyed so varied a diet as before the war.

As regards the rural areas, it is estimated that over 600 tons per month of imported foods was sold in the districts in the early part of the war. During 1942 this was reduced to 240 tons and, in 1943, to 170 tons per month. Much of this food goes to maintain the non-agricultural members of the community (shopkeepers, copra makers, dealers, bus drivers and so on). Thus, not only had the rural areas made themselves almost self-supporting in grain and ground crops but by the middle of 1943 over 400 tons per month of country produce was being sent to Zanzibar town. Besides other benefits, large sums of money were thus brought into local circulation instead of, as in the past, being sent out of the country to purchase imported foods. From the dietetic viewpoint, the substitution of local unpolished rice for the former polished product and an extension in the variety of foodstuffs grown, are having effects which may, in due course, be most important and beneficial.

The programme thus described has resulted in very heavy cropping of the somewhat limited areas of Zanzibar and the question may well be asked: "What measures are being taken or are contemplated to ensure the maintenance of soil fertility?" In the initial drive to plant up the maximum area of food crops every possible site was utilized, especially in the neighbourhood of the large town of Zanzibar.

Towards the end of 1943 it became clear that certain of the poor sandy soils near town were becoming exhausted. It was therefore decided to close these areas to cultivation from the end of the year and open them for grazing for the nearby herds of cattle which number over 3,000. Alternative sites on better-class soils were found for the cultivators thus displaced.

As regards the rice areas, the principal move for their amelioration and improvement is the introduction of a pulse rotational crop which has already been described. A rotational crop of sweet potatoes which is common practice in some areas in the dry season is discouraged as making too heavy demands upon the soil. In the cultivation of ground crops every encouragement is given to cultivation on ridges (contour ridges on sloping ground) which incorporate all the trash and previous crop residues. Compost making has been started in several places, notably near the town where several hundred tons per year are being made from waste materials mixed with the dung from the town dairies. Most of this compost is used in the growing of vegetables which has made notable progress since its introduction. Thus, every endeavour is being made to ensure the maintenance of soil fertility but there is little doubt that much will depend in the future upon the development of live stock and more closely controlled cropping.

Finally, it has to be recorded that a bumper clove crop was successfully harvested in the latter half of 1943, thus largely exploding the view, commonly held, that an extension of foodcrop cultivation would be inimical to the interests of the clove industry. There can be little doubt that the continuation of subsistence agriculture, even if on a reduced scale, must form an important aspect of post-war development in the agriculture of Zanzibar. The hard-won lessons and achievements of the war period must not be allowed to lapse.

ACKNOWLEDGMENT

The figures of produce delivered to the Zanzibar Market have kindly been supplied by the Municipal Officer, Mr. W. H. Percival to whom the author's thanks are due. As has already been stated in the introduction, the campaign described has been the work of a number of field officers and assistants in the Administrative, Agricultural, and other Government departments. The present description principally covers the work in Zanzibar Island. A similar programme has been carried out in Pemba with equally encouraging results.

FOOD PRODUCTION IN ZANZIBAR



TYPICAL COCO-NUT PLANTATION IN ZANZIBAR—PRE-WAR.—On the poorer soils especially, the palms are widely spaced and the ground is covered with weed or grass.



TYPICAL COCO-NUT PLANTATION IN ZANZIBAR, 1943.—All the ground underneath the coco-nuts has been cultivated and planted to ground crops. Cassava appears to do very well under the light shade of widely spaced palms.

FOOD PRODUCTION IN ZANZIBAR



CASSAVA SALES AT A COUNTRY MARKET.—Piles of freshly dug cassava brought for sale to the market at Mfenesini, Zanzibar. It is estimated that approximately ten tons of cassava per day pass through this country market in the season.

NOTES ON ANIMAL DISEASES—PLANT POISONING



Phytolacca dodecandra L'Herit. bush with spikes of flowers.

NOTES ON ANIMAL DISEASES

XXIV—PLANT POISONING

By J. R. Hudson, B.Sc., M.R.C.V.S., Veterinary Research Laboratory, Kabete

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We are indebted to Mr. P. J. Greenway for checking the nomenclature and for amplifying the localities given in the original draft of this contribution. He informs us that the list of poisonous species is not complete for East Africa as a whole.

Compared with some parts of the world East Africa is fortunate in the relatively small losses of stock that occur from poisonous plants. Although there are a great number of species of plants which have been shown to be toxic by drenching experiments, but a few are known to have been responsible for actual deaths under natural conditions. Many illnesses which at one time were attributed to plant poisoning, are now recognized to be caused by definite diseases and fewer suspected cases of plant poisoning are brought to the notice of the Kenya Veterinary Department now than was the case fifteen years ago.

Plants containing toxic principles occur in a great many of the natural orders: even the grasses are not exempt. In the majority of plants the concentration of the toxic principle varies in the different parts. The amount varies also at different seasons and depends on the strain of the plant and the soil on which it grows. Unless specially selected and bred for high content, the amount of toxic principle usually tends to fall when a plant is cultivated. A plant is frequently more toxic for one species of animal than for others.

Although many of the older Africans have some knowledge as to what species of plants are harmful, their statements are often unreliable and their claims as to the extreme toxicity of certain plants are usually grossly exaggerated. Similarly their opinion as to the curative value of plants in various diseases of stock is almost always devoid of foundation.

Plant poisoning is usually difficult to diagnose. Different plants act in different ways and, therefore, produce different symptoms. The active principles of the majority of our poisonous species are unknown and even when known their isolation from ingesta and their identification usually present great difficulty. Diagnosis must, therefore, rest on history and although an attempt will be made in this article to give the symptoms and post-mortem lesions seen with the forms of plant-poisoning which have been encountered naturally in East

Africa, it is necessary to point out that these symptoms and lesions are rarely characteristic. The fact that the animals had access to a particular plant or better, that the herd had seen them eating it, the presence of identifiable fragments in the first stomach of ruminants, the scarcity of harmless grazing, the fact that the animal was a stranger to the district should all be taken into consideration when attempting to make a diagnosis.

Except in the case of individual, newly-introduced, animals, isolated cases of plant poisoning are rare. Plant poisoning usually occurs as an outbreak and losses over the course of one or two days may be heavy.

CONDITIONS UNDER WHICH PLANT POISONING OCCURS

Animals which have been bred in a particular district usually know which plants are edible and which are not. Poisoning in such animals may, however, occur when grazing is scarce or when, for example, a new herd takes them to an unusual part of the farm. Animals newly introduced to a district will frequently eat toxic species of the poisonous nature of which they are ignorant. This type of poisoning is not uncommon in animals moved on the hoof over large distances. Many ornamental garden plants, e.g. *Nerium oleander*, *Cestrum* spp. are poisonous and in all countries the careless dumping of garden refuse in paddocks is a frequent cause of losses in stock.

Another cause of stock poisoning is the contamination of prepared fodder or concentrates with poisonous material which the animal might recognize and avoid in its natural state. In addition, certain foodstuffs which are harmless if fed in reasonable amounts, are toxic if fed as the main article of diet, and others, normally safe, may in isolated instances be dangerous.

PLANTS KNOWN TO HAVE CAUSED LOSSES UNDER NATURAL CONDITIONS

These plants are obviously the more important and will be dealt with in detail. Poisoning by prepared foodstuffs will then be considered and in a final section will be found a list of plants which have been shown to contain toxic principles by experiment; but evidence as to the toxicity of which under natural conditions is lacking.

Phytolacca dodecandra L'Herit.

Kikuyu: muhoko; Ndorobo: batkar; Jalu: o bok. Distribution: Kabete, Ol Joro Orok, Sotik, Maseno. [Throughout Tropical Africa.—P.J.G.]

When growing in isolation this plant forms a low, spreading bush composed of numerous stems up to about six feet in length. When in flower, the stems end in a spike (4–12 inches long) of small cream-coloured flowers. The flowers are succeeded by orange berries, the size of small peas. In forest the plant develops long, trailing stems which push their way up through the branches of the trees and flowering specimens are exceedingly difficult to obtain. The powdered bark and root are very highly toxic, the leaves and unripe fruits, somewhat less toxic and the ripe fruits, at least in small amounts, are harmless.

The plant produces great depression and quivering of the muscles. Later there is greatly increased excretion of urine and foetid diarrhoea. Acute cases show frothing at the mouth and profuse diarrhoea and dysentery. On post-mortem examination intense congestion of the stomach and intestines is found. Large haemorrhages may be present in the left ventricle of the heart and the lungs, liver, kidneys and spleen are usually congested.

Ricinus communis L. (Castor oil plant).

Kikuyu: muwariki; Swahili: mbariki; Masai: ol-dule; Nandi: imanayat. [Distribution: widespread, especially in waste places. P.J.G.]

This plant is too well known to need description. The seeds contain toxic proteins which must be removed from the oil before it is suitable for medicinal use, and losses have occurred in the past in England owing to the contamination of feeding cakes with these seeds.

A natural outbreak of poisoning has been seen in Kenya in turkeys. The birds died suddenly and on post-mortem examination showed haemorrhages in the intestines. Pieces of the characteristic hulls of the seeds were found in the gizzard.

Dichapetalum stuhlmanni Engl.

Native names: nchencheri, nyeryere, njere-ma, njenje. Distribution: common in the Lindi District of Tanganyika Territory and in the coastal strip opposite Zanzibar. [Also recorded from Morogoro.—P.J.G.]

This plant which grows in sandy areas at low altitudes, is a bush 5–7 feet high with shiny, leathery leaves 3–4 in. long by 1½–2 in. broad, tapering at the tip and base. The flowers are small with five white petals. According to Braun (1910) the local Africans are well aware of the toxic nature of this plant and tie their goats with cords when passing through areas in which it grows.

In its great toxicity the plant appears to resemble the South African species *D. cymosum* (Hook.) Engl. Braun reports that an hour after eating leaves of the plant, two sheep fell down and died in convulsions. No report of the post-mortem lesions are given; but in view of the rapid action of the poison there probably were none.*

Elaeodendron sp. nr. *E. keniense* Loes.

Kikuyu: mutanga; Kikamba: murundu; Kipsigis: sawonet.

A common tree of the Kikuyu country, particularly in the grassland around Kabete, this species is often covered with gregarious caterpillars that live in webs. The tree is a tall timber tree and when growing in the open has a round symmetrical shape. The leathery, alternate or opposite leaves with toothed margins have smooth surfaces and measure up to 7 inches long and 3½ inches broad. Although a fresh green when young they are dark green when mature. The small, green flowers are usually out of season or out of reach!

The leaves are highly poisonous to stock and severe mortality in sheep occurred on one occasion when a batch of Northern Frontier sheep, herded near Nyeri station awaiting transport to Nairobi, ate them. Death usually occurs suddenly and the post-mortem lesions are congestion of the liver, oedema of the lungs and haemorrhages in the heart. Cattle and other animals nibble young shoots as they appear around the trunk of a tree in one of the laboratory paddocks; but apparently they obtain too small a quantity to suffer harm. The toxic principle is unknown but acts by paralysing the heart.

Rhoicissus erythroides Planch.

Mettam (1930) mentions that "*Cissus erythroides*" was responsible for cases of poisoning in pigs which ate the root on a farm near Timboroa. No details of the lesions are, however, given. The plant is a woody climber very similar to a grape vine in appearance.

* Other species in East Africa, suspected to be toxic, are: *D. aureonitens* Engl. recorded from Kenya. Tanganyika and Portuguese East Africa; *D. braunii* Engl. and Krause from Dar es Salaam in Tanganyika to the Portuguese East African border; *D. macrocarpum* Engl. from the Lindi District of Tanganyika and in Portuguese East Africa; *D. mossambicense* Engl. from Dar es Salaam, Tanganyika southwards into Portuguese East Africa and *D. ruhandii* Engl. in the East and West Usambara Mountains, Tanganyika. Most of these are sprawling shrubs with evergreen leaves and are found in coastal evergreen bushland.—P.J.G.

[Distribution widespread from Eritrea southwards to Natal, Angola and the Belgian Congo.—P.J.G.]

Turraea robusta Guerke.

Chigogo: mikopora.

During 1938 heavy losses due to eating this tree occurred in a batch of cattle moving from the Iringa District to Mpwapwa for rinderpest vaccine production (Hornby 1939). The poisonous nature of the tree was confirmed by laboratory experiments, the symptoms being stated to resemble those of rinderpest.

According to Egging (1940) *Turraea robusta* is a scandent shrub or tree up to 30 feet high. The bark is grey and the leaves 3–4 inches long and $1\frac{1}{2}$ –2 $\frac{1}{4}$ inches broad. The flowers are white and the strap-shaped petals are about three times as long as the calyx. The stamens are united to form a tube little more than half as long as the petals and forming teeth which project past the anthers at the apex. The same authority gives the distribution in Uganda as Mengo, Ankole, Toro, Teso, Bugwere, Budama and Busoga. [Pugu Hills, Usambaras and Bukoba in Tanganyika.—P.J.G.]

Melia azedarach L. Persian Lilac. Syringa.

This introduced ornamental tree has poisonous fruits. Mettam records (1930 and 1937) that these drupes have been the cause of losses in poultry both in Kenya and Uganda. They are known to be toxic to pigs and other mammals as well as to poultry.

Stephanorossia palustris Chiov.

Kikuyu: murerema, muradia; Lumbwa: chemkeruki. Distribution: Found mostly along water courses at relatively high altitudes, for example on the Kinangop plateau and in the Molo District of Kenya.

The herb belongs to the parsnip family and is often called water-parsnip or water-celery by Europeans. The members of the family are difficult to distinguish and, as many are poisonous, all wild species should be treated as dangerous and eradicated from paddocks and watering places. In actual fact specimens of this species vary enormously in toxicity. Mettam (1933) first reported it as toxic and the author knows of two instances in which he is satisfied that it caused losses in cattle. Specimens from near Kabete have, however, been drenched to sheep without producing ill-effects.

The symptoms produced are rapid, noisy breathing and profuse diarrhoea. Death is pre-

ceded by a period of coma. After death acute congestion of the stomach and intestines, water-logging of the lungs, haemorrhages under the lining membranes of both the inside and outside of the heart and congestion of the liver, spleen and kidneys are found.

Agauria salicifolia (Comm. ex ham.) Hook. f. ex Oliv. var *pyrifolia* Oliv.

Kikuyu: musagita, musikita; Kipsigis: tangotuet; Masai: ologomati. Distribution: High altitudes in Kenya, generally growing on the verge of forests. Material used for experiments was obtained from Ol Kalou. Egging (1940) gives Ankole, Kigezi 6,000–10,000 feet for the typical form in Uganda.*

This is a tall timber tree in Kenya with alternate, oblong leaves $1\frac{1}{2}$ –2 $\frac{1}{2}$ inches long by 1 – $1\frac{1}{2}$ inches broad. At the end of the mid-rib is a short projecting point. The mid-rib is sunk below the smooth, upper surface of the leaf and projects below. The petiole is up to one-third of an inch long and usually pinkish in tint.

The plant was investigated by the writer following a report by Miss Margaret Collyer that the Kikuyu stated that the dead leaves were dangerous to cattle, sheep and goats causing vomiting.

Although there was no marked difference in toxicity between green and brown leaves, the experiments confirmed the fact that the plant produced vomiting. This began half an hour after drenching a sheep with a relatively small dose of dried leaves. The animal ground its teeth, salivated and whilst shaking its head vomited every few minutes. This continued for three hours when the spasms were somewhat less frequent and the animal preferred lying on its chest to standing. Later still the animal was found lying on its side in a state of coma. Occasionally it would regain consciousness for a few seconds, grind its teeth, lift its head, bleat and give several convulsive kicks with the legs. Each return to consciousness was followed by one or more periods of extremely slow respirations, some of which were thought to be the sheep's last until with a sudden gasp it breathed in again. The following morning, although unable to stand, the sheep was slightly easier, convulsions being less severe. During the day the pulse became much weaker and the respirations more shallow, and, as it was thought it would not last the night, it was killed. On post-mortem examination no lesions

*Sleumer, a recent monographer, considers this genus to be monotypic and he has grouped the species into eight varieties, two sub-varieties and ten forms. Taken collectively its distribution extends from Fernando Po, Cameroons southwards to Angola and eastwards by way of Uganda, Kenya, Tanganyika, Northern Rhodesia, Nyasaland to the Mascarene Islands and Madagascar. Its poisonous properties appear to be well known to East African highland tribes as the tree does not grow below 3,500 ft.—P.J.G.

were found other than a little congestion in the kidneys.

These symptoms are the same as those produced by andromedotoxin, the poisonous principle of rhododendrons and other plants of the heath family to which *Agauria* also belongs. The Kikuyu say that many cases can be cured if the mouth and nose are cleaned and some posho porridge is given. No doubt many mild cases, which show these distressing symptoms, vomit much of the dose of poison and hence recover.

Acocanthera friesiorum Mgf. (previously identified as *A. schimperi* Schweinf.)

Kikuyu: murichu; Kikamba: kibai; Masai: ol-morigye; Nandi and Kipsigis: keliot; Kamasia: gelwon; Meru: mururu. [Distribution: Somaliland, Kenya and north-east Tanganyika.—P.J.G.]

Acocanthera longiflora Stapf.

Kikuyu: mururu; Kikamba: kibaichiago; Meru: mururu. [Distribution: Somaliland, Kenya and north-east Tanganyika.—P.J.G.]

These trees are often called "olives" by Europeans, but since they are not related to the true olives, "arrow-poison tree" is a better name. They are similar, small, spreading trees 15 to 25 feet high, the former being widely distributed in the drier parts of Kenya at an altitude of 4,000–7,000 feet and the latter being common around Nairobi. Egging (1940) does not list the genus as occurring in Uganda. Both species have glossy, opposite leaves pointed at the tips; those of *A. friesiorum* measure $1\frac{1}{2}$ to $2\frac{1}{2}$ inches in length and 1 to $1\frac{1}{4}$ inches in breadth, and those of *A. longiflora* up to 5 inches in length and $2\frac{1}{4}$ inches in breadth. The small jasmine-scented white flowers are produced in clusters in the axils of the leaves and are succeeded by fruits 1 inch in length and red in colour in *A. friesiorum* and purple and the size of damsons in *A. longiflora* when ripe. The trees have no spines unlike the otherwise similar and closely-related *Carissa edulis* Vahl.*

The ripe fruits of both species are non-toxic and although bitter when first crushed by the teeth, leave a pleasant, sweet and refreshing taste in the mouth. At least at certain seasons on certain soils, all other parts of the trees are poisonous although Mettam (1930) states that the older leaves and branches are less toxic than the young leaves and stems, the flowers,

roots and the bark of the trunk. Mettam found that *A. longiflora* at Kabete was less toxic when material was collected during the short rains in 1927 than it had been several months earlier. This species is regarded as producing a somewhat less potent arrow-poison than *A. friesiorum*.

The vast majority of Africans and most European farmers in Kenya recognize these trees as dangerous to stock. Outbreaks of poisoning usually occur towards the end of the dry season and have been diagnosed in Laikipia, the Rift Valley and the Ngong-Nairobi-Machakos area in cattle and in sheep. In cattle death occurs suddenly and symptoms are rarely observed; but rapid, shallow breathing and diarrhoea may be noticed. Muscular spasms, convulsions, grinding of the teeth and salivation have also been reported. In sheep the history is usually similar. A milder case, which probably had not taken sufficient to cause death is reported by Mettam as showing rapid, jerky, grunting respirations, profuse, clear, slimy nasal discharge, marked congestion of the eyes and mouth, a very uneasy and anxious expression and extensive soiling of the perineal wool by liquid faeces. On post-mortem examination there are found congestion of the mucous membrane of the stomach and intestines, congestion of the liver, spleen and kidneys, pale pink lungs distended with air and haemorrhages under the inner lining of the heart. The heart is very firmly contracted and the blood dark in colour. Fragments of leaves can usually be found in the rumen contents.

The active principle is a glucoside, probably ouabain or g-strophanthin (Jacobs and Bigelow 1932) which has an action on the heart similar to that of digitalis.

Senecio ruwenzoriensis S. Moore.

[Distribution above 4,000 feet altitude in Uganda, Kenya and to south Tanganyika.—P.J.G.]

This herb, 18-30 inches high, with typical groundsel-like yellow flowers and smooth, silvery-green, slightly fleshy leaves up to $3\frac{1}{2}$ inches long, must be regarded with the greatest suspicion although its toxicity has not been proved.

In 1934 a farmer near Timau lost several imported stock kept in a small paddock in which this plant was common. Microscopically

* Some seven species of *Acocanthera* have been described and they are restricted to Eastern Africa with a discontinuous distribution from Arabia to the Cape. *Acocanthera longiflora* is the most common in Kenya and Tanganyika; a Cape species *A. venenata* (Thbg.) G. Don also found in the Transvaal and Natal unexpectedly turns up in the Iringa Highlands of Tanganyika.—P.J.G.

sections of the liver of one animal showed characteristic lesions identical with those produced by several plants of the genus *Senecio*. The symptoms reported were lack of appetite, marked straining and the passage of small amounts of semi-fluid, dark-coloured faeces. The temperature was normal until shortly before death. Lesions found after death were congestion of the lungs and slight, diffuse inflammation of the fourth stomach and intestines.

In spite of feeding and drenching large quantities of the plant to cattle, sheep and rabbits, and inoculating extracts to rabbits over long periods, no evidence of toxicity could be found. This type of *Senecio* poisoning is difficult to reproduce, however, and it is possible that at the beginning of the season, when the plants were first appearing through the soil, they contained toxic alkaloids which had disappeared later when material was sent to the writer for experimental tests. The farmer eradicated the plant from the paddock and no further losses occurred.

GRASSES WHICH PRODUCE HYDROCYANIC ACID

Henrici (1927) was the first to draw attention to the fact that, when wilting occurs, a number of African grasses produce free hydrocyanic acid. Mettam (1930) states that he identified this gas from wilting red oat grass (*Themeda triandra* Forssk.), *Aristida congesta* R. and S., *Cymbopogon excavatus* (Hochst.) Stapf., etc. The writer has found that Naivasha star grass (*Cynodon plectostachyum* (K. Sch.) Pilg.) can produce considerable quantities and there is no doubt that many of our East African species will behave similarly if collected under suitable conditions. Members of the genus *Sorghum* are frequently the cause of losses in the United States of America but no losses from this genus have been reported in Kenya.

Free hydrocyanic acid is not present in healthy plants but is formed by enzyme action under the influence of drought, frost, trampling, mowing and wilting. The healthy plants contain cyanophoretic glucosides, the amount being dependent on the climate conditions and the soil, and free acid is produced by the action of enzymes which usually accompany the glucosides in the plant. Plants which as a result of wilting, etc., contain free acid are more likely to produce toxic symptoms than plants in which the acid is still bound to the glucoside; but under certain conditions not yet fully understood, the latter also may prove

poisonous, the acid being liberated in the stomach of the animal.

In Kenya, natural cases of poisoning from wilting grasses are undoubtedly uncommon. They occur occasionally in sheep and many flock-owners recognize the condition. It is a peculiar fact that isolated cases, or a few cases, are seen from time to time, deaths usually occurring within a few hours of the flock being let out to graze. The fact that large numbers of sheep are not involved suggests that some factor connected with the individual sheep plays a part in producing the condition. It is known that the presence of certain foodstuffs, such as lucerne, in the diet retard the formation of hydrocyanic acid and that a corn ration renders animals less susceptible to poisoning (Couch 1932). Variations in acidity of the rumen contents may also play an important part in modifying the susceptibility of the sheep.

Death usually occurs too rapidly for symptoms to be detected. When seen there may be stupor, slow and deep, or gasping respirations and convulsions. No changes are usually discernible in the carcass after death; but the rumen contents may smell of hydrocyanic acid (bitter almonds), and diffuse haemorrhages may be found under the membrane lining the left ventricle of the heart.

POISONING BY CONCENTRATES AND PREPARED FOODSTUFFS

Poisoning by concentrates and prepared foodstuffs may result from two causes. The foodstuff may be contaminated with a poisonous plant or it may itself contain a poison. As an example of the former case, hay containing bracken has been found responsible for poisoning in horses (Hadwen and Bruce, 1933) in Canada. Normally horses do not eat bracken in pastures. The contamination of feeding cakes with castor oil beans has already been mentioned. Chick-wheat in Kenya often contains a high percentage of seeds of *Datura stramonium* L. and although, in experiments at Kabete we have fed considerable quantities of the seeds of this plant to a chicken for several days without producing ill-effects, the alkaloidal content of seeds from different districts is very variable and there is little doubt but that contaminated wheat has caused losses in turkeys and other poultry to which it has been fed.

Of foodstuffs, which may by themselves cause poisoning, the most important in East Africa is cotton seed. Cotton seed contains a

toxic principle called "gossypol" the quantity varying considerably with the climatic and soil conditions under which the plant has been grown. When heated in the process of oil extraction, much of the gossypol is converted into a less toxic product known as "bound gossypol" and cake made by the "hot-pressed" method is, therefore, less likely to be toxic than the original whole seed. Gossypol is much more toxic for pigs and young ruminants than for adult ruminants and cotton seed and cake should never be given to pigs or calves. These products are, however, very valuable protein supplements for adult cattle and experience over a great number of years has shown that, provided certain precautions are taken, even the whole seed can be fed to milk cows without producing harmful symptoms.

Cotton seed and the cake are poor in vitamin A and extensive investigations by many workers in America have proved that trouble experienced with a batch of cake could be obviated by improving the quality of the roughage and other components of the ration. It is better not to rely on cotton seed or cake as the sole protein supplement; but when no other concentrate is available care should be taken that good roughage containing liberal amounts of vitamin A is fed. It has already been mentioned that the toxicity of cotton seed is reduced by cooking and it is recommended that all cotton seed fed be heated to boiling point before use. Treatment in this way makes the seed more easily digested.

Cooking the seed need not involve the farmer in much extra work. The author was impressed by Major F. Joyce's simple procedure. Boiling water is a necessity at all milking bails for the sterilization of buckets after milking. Once the buckets have been sterilized in boiling water at the morning milking the cotton seed for the evening meal is tipped into the water drums which are left on the fires. By the afternoon the seed is cool. It is tipped into the feeding troughs and the drums are refilled with water and heated for the sterilization of buckets after the evening milking. Cotton seed for the morning feed is placed in the drums after the buckets have been scalded and the procedure is thus continuous.

The symptoms of cotton seed poisoning in cattle are staggering gait, weak, rapid respirations and diarrhoea. In acute cases stupor and death may occur in 24 hours; but subacute cases may recover if the ration is speedily changed. On post-mortem examination the blood is found thick and dark in colour and

scattered haemorrhages are found in and on most of the internal organs. The lungs are oedematous and the chest cavity usually contains blood-stained fluid. Blood-stained froth is often present in the wind-pipe. Fluid may be present in the abdominal cavity.

In pigs Binns (1938) describing an outbreak in Nyasaland records that all deaths were very sudden. There was great respiratory distress; the pigs showed typical signs of asphyxia, breathing became stertorous and then gasping, and within half-an-hour of the onset, the pigs died in convulsions. On post-mortem examination clear, straw-coloured exudate was found in both the chest and abdomen. The wind-pipe contained frothy, blood-stained fluid. The lungs were brick-red to purple in colour and markedly oedematous, their surface was bulging and firm. The liver and kidneys were swollen and congested and the latter showed numerous small haemorrhages in the outer layer. The spleen was normal. The mucous membrane of the stomach showed slightly haemorrhagic, catarrhal inflammation, more marked towards the intestinal end. The intestinal mucosa was catarrhal and haemorrhagic patches occurred throughout the small intestine. French (1942) records experiments on feeding whole cotton seed to pigs in Tanganyika Territory. His pigs "went off feed, showed a listless condition with laboured breathing and a high temperature for two days and then died". Post-mortem lesions were similar to those recorded by Binns.

Some batches of linseed contain a cyanophoretic glucoside and an enzyme which is capable of hydrolysing the glucoside thus liberating hydrocyanic acid. The enzyme is readily inactivated by heat and the temperature to which the seed is heated during the extraction of oil is sufficient to render the cake safe. When preparing feeds from the whole seed, however, it is advisable to add water and bring to the boil before use. Cassava root (muhogo) contains a similar glucoside, the amount varying greatly with the strain of plant.

Another peculiar form of poisoning by food-stuffs which are normally harmless is that known as "oat-hay poisoning" since it occurs occasionally when oat hay or straw is fed. This condition has been seen once at Kabete when it followed feeding with Napier grass. Three heifer calves about nine months old, which had been running out, were brought into a stable for experimental work. About noon a ration of freshly cut Napier grass was placed in the stable, many other animals in the stables

receiving some of the same green fodder. Less than half an hour later one of the animals was reported dead. A post-mortem examination was made at once and as the writer returned from the post-mortem room the stable boy reported that another had died. The third calf was then seen to be jumping into the air at intervals and standing with quivering muscles and straining when not actually leaping. In a few minutes it also died.

All three animals showed identical lesions, the most important being the chocolate-brown colour of the blood. As a result of the abnormal colour of the blood the lungs, liver and kidneys were brown; but the muscles were of a normal tint. Two animals were slightly "blown". The stomach and intestines were normal except for congestion at the anus, the result of straining. The heart was firmly contracted and the spleen slightly swollen. No other cases occurred and it would appear that the three calves that died were more susceptible to the condition since they had not received Napier grass previously.

This type of poisoning is due to the presence of an unusually high percentage of nitrates in the plant. Rapid absorption of nitrates causes the haemoglobin, which carries oxygen round the body in the blood, to be converted into methaemoglobin which is unable to function as an oxygen carrier and death occurs from asphyxia. The writer has heard of no other similar cases in East Africa.

Although most farmers are aware of the fact, it may be as well to mention that potatoes when green or sprouting may contain sufficient of the alkaloid solanin to be poisonous to stock and to poultry.

PLANTS PROVED POISONOUS BY EXPERIMENT BUT NOT YET SHOWN TO PRODUCE POISONING UNDER NATURAL CONDITIONS IN EAST AFRICA

The plants listed below should be regarded as potentially dangerous. They may be eaten by animals unaccustomed to them or some of them may develop toxic properties under certain climatic conditions although usually quite harmless.

Ranunculus pinnatus Poir.—A common buttercup in East Africa was shown by Mettam (1933) to be toxic for sheep.

Tribulus terrestris L.—This plant, particularly common in the Kaisut Desert, is at times responsible for heavy losses in sheep in South Africa where it is known as "dubbeltjie". The condition is called "geel-dikkop" and is

characterized by yellowing of the whites of the eyes, lips and mouth and swelling and peeling of the skin of the lips, nostrils, ears, eyelids, etc. "Geel-dikkop" has not been seen in Kenya and feeding of the plant at Kabete has not produced toxic symptoms. It is known, however, that the disease only occurs in South Africa under definite weather conditions and that the plants develop higher toxic properties on some soils than on others.

Oxalis corniculata L.—Luganda: kajampuni. Mettam (1935) showed that although readily eaten by sheep, this common weed can cause death.

Adenia volkensii Harms.—Kikamba: kiliam-biti.

The succulent stem has been shown by the writer to contain a cyanophoretic glucoside and a fixed toxic principle. The plant is one of the most toxic that he has tested.

Cucumis ficifolius A. Rich.—This wild cucumber was proved poisonous to sheep by Mettam (1933). In South Africa related species have caused deaths on farms during periods of drought.

Adenopus abyssinicus Hook f.—Kikuyu: margi.

Another member of the cucumber family, this plant was also proved to be poisonous by Mettam (1933).

Cassia didymobotrya Frese.—Kikuyu: mwenu; Masai: ol-senetoi; Nandi and Kipsigis: senetuet.

Mettam (1930) proved this common wild cassia toxic.

Eriosema glomeratum Hook. f.—Luganda: kainamuti akokutale.

Tephrosia eriosemoides Oliv.—Luganda: muluku omutano.

Crotalaria mesopontica Taub.—Luganda: mukalisa.

The toxic nature of these three leguminous plants was demonstrated by Mettam (1935) in Uganda.

Maesa lanceolata Forssk.—Luganda: ki-wondowondo; Kikuyu: mundonye, mundume; Masai: ol-reteti; Nandi and Kipsigis: kibabustaniet.

Mettam (1935) found this bush or tree poisonous in Uganda.

Asclepias physocarpa Schltr.—The toxicity of this species was demonstrated by Mettam (1930). All milkweeds should be regarded as dangerous.

Erlangea tomentosa S. Moore.—Luganda: twatwa.

Ageratum conyzoides L.—Luganda: nami-rembe.

Senecio abyssinicus Sch. Bip.—Luganda: mukasa.

Found toxic by Mettam (1935) in Uganda.

Dicrocephala chrysanthemifolia DC.—Kikuyu: kamugwata-ng'ondo.

This plant was shown to be toxic to sheep by Mettam (1930).

Hoslundia opposita Vahl.—Luganda: kamunye.

Leonotis africana Boiq.—Luganda: kifumufumu.

These two labiates were proved poisonous by Mettam (1935) in Uganda.

Leonotis mollissima Guerke.—This plant with whorls of orange-red flowers in spiny calices was stated to be poisonous by Mettam (1930). The species at Kabete with which Mettam more probably worked is however *L. nepetaefolia* R. Br., *L. mollissima* occurs at higher altitudes.

Gloriosa virescens Lindl.—Kikuyu: mburiru.

This "superb lily" was proved toxic by Mettam (1930).

Ornithogalum longibracteatum Jacq.—Kikuyu: kikwashi.

This plant, related to the toxic South African *O. thyrsoides* Jacq., Star of Bethlehem or "chinkerichee" was shown to be poisonous by Mettam (1930).

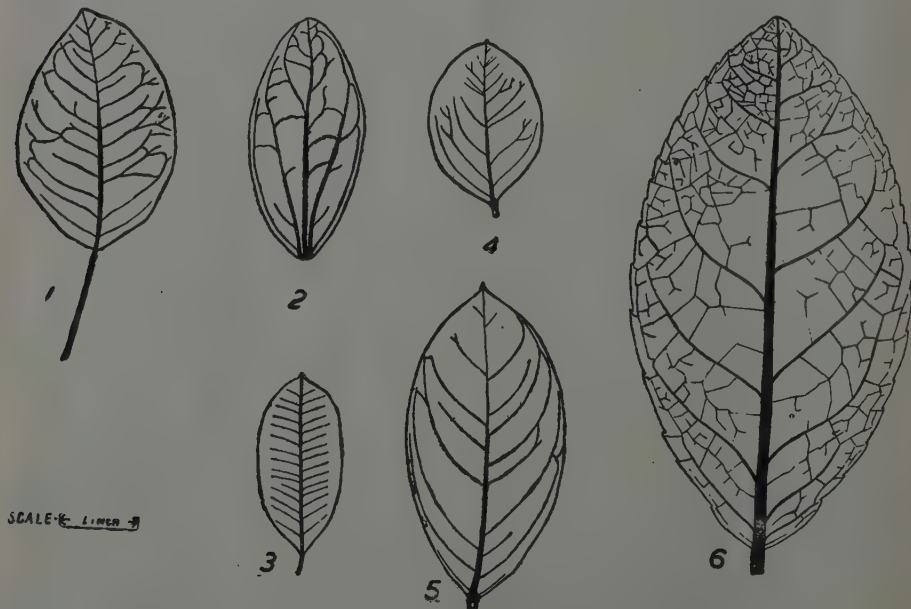


FIG. 1—*Phytolacca dodecandra* L'Herit.

FIG. 2—*Senecio ruwenzoriensis* S. Moore

FIG. 3—*Agauria salicifolia* var. *pyrifolia* Oliv.

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Notes on the distribution of plants and many of the native names have been taken from "Trees and Shrubs of Kenya Colony", the revised edition of "Battiscombe", Nairobi, 1936. The writer is also indebted to Mrs. E. R. Malony and Mr. P. R. O. Bally for assistance in the identification of many of the plants with which he himself has worked.

FIG. 4—*Acocanthera friesiorum* Markgr.

FIG. 5—*Acocanthera longiflora* Stapf.

FIG. 6—*Elaeodendron* sp. nr. *E. kenianse* Loes.

A NOTE ON THE COST OF ROOTING CUTTINGS OF *COFFEA ARABICA*

By S. M. Gilbert, Chief Scientific Officer, Coffee Research and Experimental Station, Lyamungu, Moshi, Tanganyika Territory

(Received for publication on 10th July, 1944)

The work of rooting cuttings of *Coffea arabica* has proceeded without serious interruption on a fairly large scale, from 1939 to date.

The process is now on a commercial scale as the following table indicates:—

CUTTINGS ROOTED

1939	1940	1941	1942	1943
6,804	6,596	4,654	7,407	5,979

So far in Tanganyika Territory this work has been confined to this station and it is desirable, when normal conditions return, that professional nurserymen or "go ahead" planters should take it up. It is justified if only on the grounds of uniformity in the merchantable type of coffee produced.

EQUIPMENT NECESSARY

The plant at this station comprises six batteries containing forty-six compartments each capable of dealing with about 200 cuttings. Cuttings take on an average eighteen weeks to root. Thus in any one year about 18,000 can be set out. Allowing for minor catastrophes such as "damping-off", leaf-fall, cuttings which do not root within six months, and deaths from other causes, about 10,000 cuttings should root each year. That our results do not reach this number is so far due to lack of ample suitable material for cuttings. For "hardening-off" after potting up there are twenty-four large single-row frames built against the walls of three potting sheds. No special provision is made for further "hardening-off" outside the frames except that artificial shade is provided. The potted cuttings stand on the ground and are subsequently planted in beds until required in the field.

The equipment is not described here in detail as it has already been described by Fernie (*E.A. Agric. Journ.*, March 1940, p. 323).

CAPITAL EXPENDITURE

(Pre-war prices)

The following quantities were employed in two 6-frame propagators erected by the station staff:—

Material	Sh.	cts.
Timber	99	08
Wire nails, 2 in. .. .	1	36
Bolts, nuts and washers 8 in. by $\frac{1}{2}$ in. .. .	1	49
Brass hinges, 4 in. .. .	26	95
Barrels, cement .. .	96	36
Screws .. .	2	09
Sheets, glass 18 in. by 21 in. .. .	77	12
Sheets, glass 18 in. by 19 in. .. .	30	00
Sand, river .. .	40	00
Stone (Sh. 1/50 a cubic metre) .. .	40	00
Half roll wire netting for concrete work 72 in. by $\frac{1}{2}$ in. mesh .. .	40	00
Sundry items, i.e. transport .. .	20	55
Labour .. .	65	00
Total:	Sh. 500	00

The Public Works Department erected the first two similar batteries for £30. Thus a fair amount to be charged to capital for the complete set of propagators is about £120. The lean-to frames cost about £50. The potting sheds, which are employed almost entirely on propagation work, cost £150, making a total of £320. This comprises all the capital expenditure.

RECURRENT EXPENDITURE

(a) Materials.	Sh.	cts.
Peat moss .. .	110	00
Hessian cloth for overhead shade .. .	300	00
Decayed coco-nut fibre .. .	60	00
Orthol K against scale, etc. .. .	20	00
Hose $\frac{1}{2}$ in. 120 ft. .. .	75	00
Syringe, Abol .. .	25	00
Watering cans (special rose) .. .	16	00
Sand and stone (for drainage)—		
Labour and freight .. .	50	00
Wire netting 72 in. by 2 in. (50-yard roll for shade) .. .	24	00
Canvas for side shade Sh. 2/75 per yard .. .	180	00
Glass for replacing breakages .. .	20	00
Sundries, i.e. transport, etc. .. .	20	00
Total	Sh. 900	00

Compost is not included as it is difficult to apportion a fair cost. A reasonable estimate is probably in the neighbourhood of Sh. 3/50 per ton and mixed with soil and sand this quantity would fill very many baskets. Stone for drainage is obtained on the station and is practically free of cost. Certain equipment such as sieves are needed but only for small periods and form part of the general equipment of the station.

Thus 10,000 rooted cuttings cost in material:—	£
Writing off £320 capital over ten years	32
Material	45
Total:	£77

Cost per cutting is cents $15\frac{1}{2}$ = $1\frac{1}{2}$ d.

LABOUR

Coffee bushes are specially trained by bending over the stems to obtain readily material suitable for cuttings and the cost of this work would appear to be a fair charge against the true cost of rooting cuttings. The taking of the cuttings is done by a skilled labourer.

Attention to the frames is skilled work and the men engaged are paid higher than ordinary labourers. Baskets are made by children on piece-work from bananas grown on the station for mulching purposes. The upkeep of the bananas is small and a nominal sum only is debited to the baskets. The annual cost of the labour is thus:—

Propagator: 1 at Sh. 50 per month	30	0
Skilled nurserymen: 2 at Sh. 25 per month	30	0
Labourers: 3 at Sh. 17/50 per month	31	4
Children for baskets and weeding: 3 at Sh. 12 per month	21	12
Total:	£112	16

Cost per cutting in labour is cents

$$22\frac{1}{2} = 2\frac{1}{4}\text{d.}$$

The total cost per cutting is thus cents $38 = 4\frac{1}{2}$ d.

It is seen that a rooted cutting of *Coffea arabica* costs cents 38 approximately in Tanganyika Territory.

EROSION

In New Zealand, at least, a recognition of one of the causes of erosion, namely, unchecked firing of the countryside, has begun to make its appearance. In the Dominion Forestry Report (March, 1942) on the subject of soil erosion one reads:—

"Forest clearing and grassing have ceased on all State-owned lands, and attempts to grow one blade of grass where two grew before are now recognized as the root cause of the Dominion's erosion problem. Should further forest clearing be allowed on any lands—private or native—if it contributes to accelerated erosion? In the belief that the public is convinced of the necessity for controlled clearing of all forested land, irrespective of ownership, appropriate recommendations are being drafted for consideration by the Government."

In how many of the Colonies of the British Empire could such a statement be made? A great deal has been heard recently of the attempts to improve agricultural methods there. In the past, every effort was made to improve the commercial and financial position—the so-called development of the Colony—by the introduction and growth of crops of tea, coffee, cocoa, sugar, rubber and so forth, all at the expense of the forest, for the develop-

ment was made by the large-scale felling of the most valuable, because the richest in commercial timber species, of the forest areas. For a time, all went well. Wealth came to the Colony and the planters, while the natives continued their old practices of shifting cultivation, etc., in the rest of the accessible forests. But the rich forest soil, the product of centuries of conservation under the canopy of the trees, gradually became used up and dissipated when exposed, for little protection was afforded to it by the crops grown. We are now facing the results to be expected, and the British taxpayer will be called upon to foot the bill.

The administrations still appear to regard it as a purely agricultural matter. More research, it is said, will lead to a better, because more intensive, agriculture. Is this a logical conclusion because, in isolated instances, a Colonial agricultural department can show, on a small scale, the example of a success? In Africa it is beyond question that the soil of the Continent is becoming increasingly impoverished by the very means by which great tracts of that old Continent have become reduced to desert, or practically desert conditions, by man in the past.

Extracted from *Nature*, Vol. 151, No. 3841, June 12, 1943, p. 653.

NOTES ON CASSAVA PREPARATION IN NORTH KAVIRONDO AND SAMIA

By G. W. Anderson, B.Sc., A.I.C.T.A., Department of Agriculture, Kenya

(Received for publication on 11th July, 1944)

Innumerable types of cassava are grown in the Samia and North Kavirondo areas, but of these, six are most generally popular mainly for the reason that they are, with one exception, early to medium in maturity and at the same time "sweet". That is to say they have not the strong bitter flavour of later maturing types—a bitterness which necessitates a longer method of preparation and which prevents the roots being used until they are almost fully developed.

Of these popular varieties the earliest is *Mbironyango*, a variety introduced to the Bantus from Jaluo country, which matures in about eight months but which can be lifted and used in four. Next in order of maturity come four varieties which mature in about a year, but they also can be lifted early—anything from six months onwards. These are, *Miti juma* and *Dodo*, two varieties believed to have come in the first instance from the Uganda side of the border; *Khasimbasio* and *Namugassa*, two locally named types which appear to have been in cultivation for several generations.

Miti juma and *Khasimbasio* are two of the most common. The former for the reason that, although an early cassava, the roots can remain in the ground after reaching maturity for a period of up to three or four years without deterioration—a very popular characteristic in areas where the people are not prone to over-exertion. *Khasimbasio* is popular for the reason that it yields quite heavily and, according to general belief amongst native growers, does not suffer to the same extent as other varieties from mosaic diseases.

A slightly later type quite commonly grown is *Nakhajanjalo*, another locally named variety which takes about fourteen months and, being a bitter cassava, is not as a rule used until mature.

Normal preparation of the cassava roots consists in lifting, peeling, splitting and drying. After lifting, the roots are scraped, sometimes washed, and the skin sliced off in thin shavings. The peeled roots are then split open and laid out in the sun to dry. The rapidity with which drying takes place naturally varies with the length of exposure and the size of the splits, but in ordinary circumstances it takes about a week to completely dry a sample. In most areas drying the fresh roots is the normal practice,

the final product being clean, white and quite hard. There are areas, however, where there is a preference for developing moulds in the material as this is said to make the final product much sweeter and easier to grind. This method is accomplished by stacking the wet peeled roots in a dark store for ten days or a fortnight until black and red moulds have developed, after which the roots are taken out, split and dried as before. The result with this process is a most unappetising looking article, a dirty grey in colour tinged with streaks and blotches of red and black, but apparently much appreciated by those who like it. The dried material is then stored until required for consumption.

Before cooking, the splits are broken up into small fragments about the size of a butter bean and mixed with whatever cereal is available—most commonly *mtama* (sorghum) or *uimbi* (finger millet) or both together are used. If both are used in the mixture, the proportions are: 1 measure of cassava, 2 of *mtama*, 1 of *uimbi*. With *mtama* alone: 1 of cassava to 1 of *mtama*. The mixture is then ground and the meal cooked in one of two ways. Either the bulk of the meal to be cooked is put into a pot of hot water and left until the water bubbles right through, when more meal is added to get the desired consistency, or the meal is stirred slowly, bit by bit, into boiling water. The general consensus of opinion is that the first method is to be preferred as it entails slightly less work.

The dried cassava is not very commonly used alone, but is sometimes so used to make a fine gruel. The cassava chips are ground separately and the resulting flour cooked by dribbling it slowly into boiling water. Said to be a very satisfying food.

The preparation of the bitter types of cassava varies only slightly from the method outlined, in that prior to splitting and drying, the roots are soaked for varying periods in water. With a variety such as *Nakhajanjalo*, which is not exceptionally bitter, soaking may only be a matter of a few hours and might on certain occasions be omitted altogether. With stronger and later varieties soaking is generally considered essential and may be prolonged for as much as two days, as is the case in preparing

the roots of the *Namutumba* variety, a freak which takes from eight to ten years to develop fully.

The advantage of the 'sweet varieties is that they can be used fresh as well as after the drying process. When used fresh, the young roots are lifted, cleaned, peeled and cooked almost at once. They are sliced, put into a pot with hot water and cooked until soft. They may be eaten in this stage (rather like English potatoes) or the cooking can be continued until the roots are mushy, when excess water is poured off and the residue mashed.

Grinding of the cassava chips, with or without the admixture of cereal, is done between two stones (a flat base stone sloped at an angle on the ground and a round crushing stone held in the hands) or by means of small hand-machines. Quite a fine flour is produced but the process is very laborious if large quantities of meal are required.

The finest cassava flour is obtained when grinding is done in a power mill, but certain precautions have to be observed. Unless the material to be ground is absolutely dry and broken into small chips before feeding into the

mill, the result is just a horribly sticky mass which completely gums up the works. One other snag has also to be overcome. When properly dried cassava chips are ground in a high-speed mill the flour produced is finer than wheat flour and very liable to blow about. All chinks in the pipes feeding the bagging chutes must, therefore, be plugged, otherwise losses of flour are liable to be quite heavy. The most laborious part of the whole job is breaking up the lumps of cassava, which are extremely tough, into sufficiently fine chips. A gang of three or four labourers with hammers, the heavier the better, will be required to keep the feed box full while the mill is working.

Owing to the fineness of the flour, which makes it almost incompressible, bags must be sound, and should only be filled to 150 lb. weight, otherwise a sack carelessly dropped is quite likely to burst like a bomb and waste the entire contents.

The chips are fed into the mill rather more slowly than is the case with maize—quick feeding into the mill will almost certainly cause trouble—and with a 4,000 r.p.m. hammer-mill seven or eight bags can be done per hour.

INDISCREET PASSION FOR TILLAGE

In Norway and Russia, timber is much less easily obtained than it was an hundred years ago; because the forests nearest to the harbours on the sea coast, and to the great rivers, have been gradually cut down, for the convenience of exportation. In some parts of those northern countries, the scantiness of provisions obliges the inhabitants to bring as much of the surface under cultivation as they can manage; and for this purpose they clear the woods, as done in North America, by setting fire to the trees, after which, the plough is introduced among the charred trunks and the ground roughly scratched.

This is a practice which may, in truth, be called an indiscreet passion for tillage, and is often in their case, as also in that of the Americans, productive of the worst consequences. The thin soil, loosened by the implements of culture, and pulverized by the summer heats, is soon swept away by the rains of

autumn, and leaves the bare rock encumbered, sometimes with loose masses of granite. No trees spring up to cover the surface, for the scattered seeds can hardly take root; the tender shoots, now without shelter, cannot withstand the fury of the piercing winds; and thus are whole tracts condemned to perpetual sterility. If to this we add the increasing state of the Arctic [*sic.*] ice, which must render the climate of those northern countries still more rigorously cold, we must expect that a progressive and insuperable hostility to the growth of plants, will there be the natural result.

A footnote adds: * The same indiscreet passion for tillage is observed to take place in some parts of England; for example, in Essex, where immense quantities of timber have fallen before the axe and the mattock, to make way for corn.

From "Observations on the climate of Ireland, and researches concerning its nature from very early periods to the present time. . . ." By William Patterson, M.D., etc., Dublin, 1804.

COLLAPSIBLE VEGETABLE AND FRUIT CRATE

By A. H. B. Childs, M.R.A.C., Q.A.L.A.S., Agricultural Assistant, Tanganyika Territory

(Received for publication on 5th June, 1944)

The main object of the crate is to save space on the railways, when returning empties. Two collapsed crates take up the same amount of room as one erect one. If desired the crate can be taken to pieces, and returned at a cheaper rate.

The crate described below has been found to be a convenient size for handling, it has approximately the same capacity as a petrol box. The internal dimensions are 1' 8" × 1' 3" × 10". The weight if made of podocarpus is between 7 and 8 kilos, if of mvule between 10 and 12 kilos, and it will contain 20 to 22 kilos of tomatoes or oranges. It has also been used for packing other varieties of vegetables such as carrots, green beans, peas, chillies, leeks, etc. For varieties such as turnips and beetroot a larger crate of similar design has been used.

It has been found that repairs to this type of crate are simpler than to the erect type, as all that is required is the replacement of a section or sections. The crate has been used by the Agricultural Department for transporting vegetables between Mombo and Nairobi for the last six months. On each round trip the crates have to be handled on eight occasions. They have stood up to the journey fairly well, but it has been necessary to make minor repairs to 15 per cent or 20 per cent and major repairs to a few on each returned consignment. On short trips such as Mombo to Tanga most of them have come back in good condition.

The cost of the crate varies with the type of timber used. Below are the approximate costings for 100 crates made of podocarpus at the controlled rate for timber in Tanganyika:—

Timber—

Running feet	Board feet	Sh. cts.
750' of 3" × $\frac{3}{4}$ "	117.2	32 81
2,475' of 3" × $\frac{1}{2}$ "	309.3	92 90
950' of 1" × $1\frac{1}{2}$ "	118.7	28 48
		154 19

Semi-skilled labour is all that is required for the manufacture of the crates. It was found that if jigs were used and the labour distributed

as shown below, 25 men could easily make 100 complete crates in one day.

6 men nailing sections together on jigs as (1 man, 100 bottom sections; 1 man, 100 top sections; 2 men, 200 side sections; 2 men 200 end sections);

3 men boring holes in sections for string;

2 men marking timber in required lengths;

6 men cutting timber in required lengths;

8 men assembling sections.

25 men at 55 cents per day .. Sh. 13/75

1 headman at Sh. 1 per day Sh. 1/00

Sh. 14/75

Sisal twine was used at points B and C; green sisal or bush string at A. Approximate cost of string and twine: Sh. 4.

Nails—

$1\frac{1}{2}$ in.* and $1\frac{1}{4}$ in. wire nails were used. Number per crate 66 or 2 lb. for 100 crates at 48 cents per lb.: Cents 96.

Total cost of labour and material per 100 crates: Sh. 173/90.

Assembling

The crate is assembled as illustrated in diagram III.

Collapsing the Crate

1. Remove the top.
2. The string is cut or undone at points marked A. The string at points B and C is left intact. See diagram I.
3. The ends of the crate are then folded forward and the sides under. See diagram II.

Dimensions (overall)

Bottom of crate: 21 in. by 15 in.

Top of crate: 21 in. by 12 in.

Sides of crate: 21 in. by $10\frac{1}{2}$ in.

Ends of crate: 15 in. by 11 in.

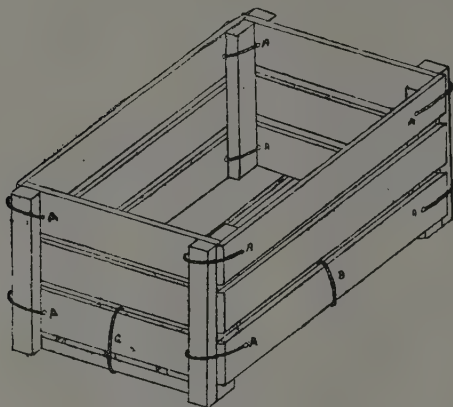


Diagram I

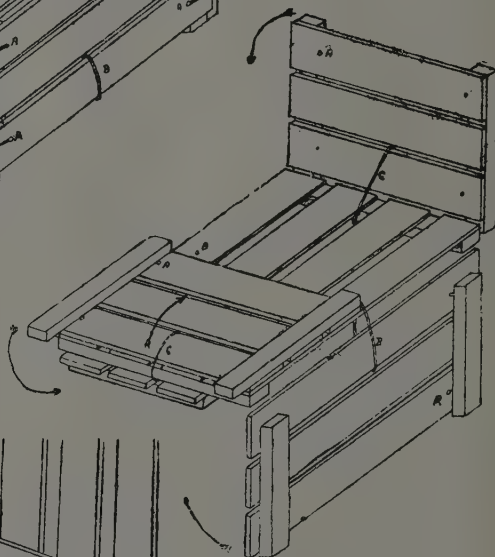


Diagram II

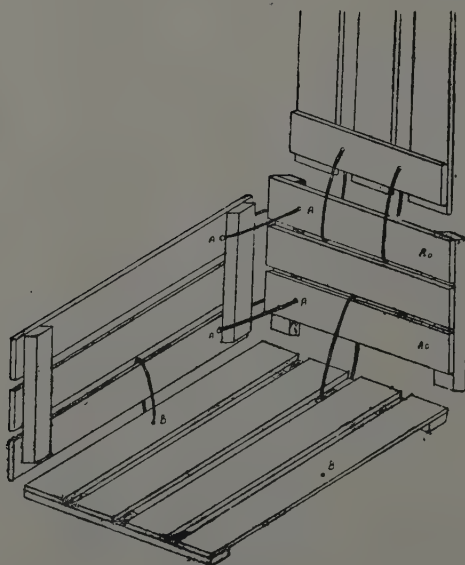


Diagram III

ORIGINS OF SOME EAST AFRICAN FOOD PLANTS PART II

By P. J. Greenway, Systematic Botanist, East African Agricultural Research Institute, Amani

FRUITS—(Contd.)

BANANAS AND PLANTAINS—(contd.)—In the different plantain-growing districts there are numerous native variety names which could be applied to the same varieties under other native names in other districts. Where and how they have all originated it is difficult to say. As they seldom set seed it cannot be by cross-pollination and is presumably as a result of bud sports. It is doubtful if they would cross with the wild types of which there are some eight species, all with fruits filled with seeds and non-stoloniferous.

BREAD-FRUIT, *Artocarpus communis* Forst. *Mfenesi wa kizungu, Mpapai wa kishesheli* and *Mshesheli*. This tree is a native of Polynesia and was, according to Burton, introduced into Zanzibar from the Seychelles. It is by no means common on the mainland but in places on the coast of Tanganyika has been introduced from Réunion by missionaries.

JAK, or JACK-FRUIT, *Artocarpus integra* (Thunb.) Merr. *Mfenesi*. This tree is locally common in fairly high rainfall areas on the coast. It is a native of India, where it is of very ancient cultivation and its introduction into East Africa must have been at an early date through Arab and Indian traders.

CAPE GOOSEBERRY, *Physalis peruviana* L. A South American plant said to have been introduced into Africa by the Portuguese. It is recorded as wild in Uganda, Kenya and Nyasaland, and it has now run wild and is very common in the West Usambaras, where it was first grown in 1896 from a small quantity of seed obtained from the region of Lake Nyasa.

CITRUS, the genus to which the citron, lemon, lime, orange, pumelo and tangerine or mandarin belong is Asiatic in origin. The botanical name is an ancient name of a fragrant African wood, afterwards transferred to the citron.

CITRON, *Citrus medica* L. *Mfurungu*. This is by no means a common fruit on the East African coast. It is either a native of India or introduced there from further east. Its introduction into East Africa may have been very early perhaps through the Persian settlements on the coast. It had reached Persia before the time of the Achaemenides, and Alexander the Great's invasion of Persia (331-330 B.C.) brought an accurate knowledge of it to the Greeks. It was brought to Italy about the time of Christ and gradually became established there. The species has some ill-defined varieties, including the Fingered Citron, var. *sarcodactylis* (v. Nooten) Swingle.

LEMON, *C. limonia* Osbeck. *Mlimau, Mlimao*. This is a fairly common fruit on the East African coast. Like the citron, it is either a native of India or introduced there from further east. The vernacular name *limau* is a standard Malay word for the citrus fruit as it comes from the tree and is used in Sumatra, *limu* is used in eastern Malaysia, and is the word used for sour citrus in Arabic and Persian, these peoples having borrowed it from India and modified the word. The Portuguese used *limao* for a lemon, whilst the Cantonese *li-mung* for a sour lemon. I think one will have to go back earlier than the Portuguese occupation of East Africa for the time of the introduction of the lemon. It may have come from Malaysia by way of the Hovas of Madagascar or through Persian, Arab or Indian traders. It is believed to have reached the Mediterranean by the third century. There are numerous cultivated varieties.

LIME, *C. aurantifolia* Swingle. *Mdimu*. This fruit seems to be more common down the East African coast than the lemon. The race most generally seen on native markets is globose, about 1½ inches in diameter with a thin skin, its most common form, and differs from the West Indian lime, which has slightly elongated fruits. It is a native of India and south-eastern Asia and was established on the East African coast long before the Portuguese. It did not reach the Mediterranean until about the ninth or tenth century, perhaps because of its climatic requirements, as it is more tropical than the citron or lemon.

ORANGE, Sour or Seville Orange, *C. aurantium* L. Sweet Orange, *C. sinensis* Osbeck. *Mchungwa, Mdanzi*. The sour and sweet orange are natives of China or Cochin China and according to Portuguese records one or the other, perhaps both, were well enough established on the East African coast for some Mohammedans to give Vasco da Gama a present of oranges when he anchored in April, 1449, off the north-east Tanganyika coast.

The sour orange reached the Mediterranean in the ninth or tenth century and was well known in Europe long before the sweet orange which was not known till about the fourteenth century. Oranges may have reached East Africa through the agency of the early Persian, Arab or Indian traders or have been brought across from Madagascar long before the fruit reached the Mediterranean. Many varieties of the sweet orange have arisen through cultiva-

tion, including one which when ripe has a green skin and is the kind generally seen on native markets down the coast.

PUMELO, PUMMELO OR SHADDOCK, *C. maxima* (Burm.) Merr. *Mbalungi*. This is a native of Indio-China, Siam and Malaysia and is more common in Zanzibar and Pemba than on the East African mainland. The pink-fleshed form is the one most commonly met with. It is probably a comparatively recent introduction by the Arabs. The name Shaddock originated in the West Indies from a Captain Shaddock, a master of an East India sailing ship, who left the seed of this fruit tree when he touched at Barbados some time before the close of the seventeenth century.

TANGERINE, MANDARIN ORANGE, *C. nobilis* Lour. *Mchenza*. This is very closely allied to *C. aurantium*, and is very probably a cultigen* of China and certainly of the East.

It is locally common on the East African coast. This is also probably a comparatively recent introduction by the Arabs or Indians into and by way of Zanzibar. It did not reach the Mediterranean till the last century.

DATE, *Phoenix dactylifera* L. *Mtende*. This has been a cultivated tree from far back in prehistoric times in the dry belt from Senegal to the Indus. The Arabs depend so greatly upon it for food that they have tried to grow it wherever they have settled. It is always an item in the provisions of ships carrying Arabs or Persians, who took it as far as China as the Chinese knew it well enough to call it the Persian jubbe as early as A.D. 618-907 during the Tang dynasty. Single date palms can be observed on the East African coast, where the climate is not suited to its growth, but they have been well established in and around Tabora in Tanganyika. Their appearance here is no doubt due to the early Arab slavers and traders who established a depot there between 1830 and 1852.

DURIAN, *Durio zibethinus* L. *Mduriani*, *Mfenesi wa kizungu*. This tree is believed to be a native of Borneo and is in cultivation throughout Malaysia. It is in cultivation in Zanzibar and possibly in isolated places on the coast of the East African mainland. It is recorded by the explorers von der Decken (1833-1865), and Burton in Zanzibar between 1850 and 1860 and is believed to have been introduced by the Arabs from Réunion or the Seychelles at the beginning of the nineteenth century.

GRAPE, *Vitis vinifera* L. *Mzabibu*. This is native of Eastern Europe and Western Asia

and it has been used by man from a very remote period in the Mediterranean, the near East, and ancient Egypt. It was well known in northern India before the Christian era and there is an account of its introduction in 126 B.C. into China overland from Persia. The Arabs distributed it around the Indian Ocean as far as Java and Zanzibar, but its actual date of introduction into East Africa is not known. Several varieties have been introduced up-country since the end of last century by missionaries and others.

GRENADILLA, *Passiflora edulis* Sims. This is native of Brazil and was introduced into Tanganyika from Natal in 1896. It does well in the cooler and damper parts of East Africa and is becoming naturalized in the Usambara, Pare and Uluguru Mountains in Tanganyika.

GUAVA, *Psidium guajava* L. *Mapera*, *Mpera*. The original home of this fruit, now widespread throughout the tropics, is tropical America, and it is believed to have been distributed between Mexico and Peru before the discovery of the New World. It was first described in 1526 by Oviedo, under the name *guayabo*, who says the best ones were to be found in the Isthmus of Darien. The fruit is known as *guayaba* in the Philippine Islands, and from this it seems evident that the Spaniards carried it across the Pacific to Manila. Rheede, the celebrated Dutch botanist and administrator (c. 1636-1691), in his *Hortus Malabaricus* in 1682 refers to it as *peera*, that is "pear" in the Portuguese of Goa and Malabar coasts, and he further states that the Brahmin traders of the Malabar coast called it *pera* and *pela* like the Portuguese. From this one can assume that the guava was carried from the New to the Old World both westwards by the Spaniards and eastwards by the Portuguese to India. It may have reached East Africa between 1510 and 1550 by way of Mozambique, or at a later date from the Portuguese settlement at Goa which was well established by 1563. The Portuguese name has become the Swahili. The guava was recorded in 1799 in Zanzibar by Lieutenant Bissel and was observed in 1757 in Senegambia by the French botanist and traveller, Adanson (1727-1806). It is now wild in many places in East Africa.

INDIAN ALMOND, *Terminalia catappa* L. *Mkungu*. This is a large tree native on sandy beaches of Asia and Polynesia, also extensively planted as a roadside or ornamental tree in the tropics. It has been recorded wild in Madagascar, Mauritius and the Seychelles. It may

* Cultigen, a plant, group or series, only known in cultivation.

have been introduced by the Arabs or Indians from the Persian Gulf or India for the sake of the edible kernel, which is somewhat difficult to extract from its hard shell. The fruit will float readily in water for many months and its appearance on the East African littoral is no doubt due to sea drift possibly by way of Madagascar. It has also been planted by Europeans as a roadside tree in the coastal towns.

INDIAN JUJUBE, CHINESE DATE, *Ziziphus jujuba* Lam. *Mkunazi*. There is much confusion over the correct botanical identity of this fruit tree. It is wild and cultivated in India and China, in the latter country over 300 to 400 races or forms are recorded. It is found wild in the drier parts of Africa but may have originally been introduced by various routes at a very early date from the Persian Gulf and India. Its distribution up-country in East Africa may have also been due to Arab slavers as it is usually found in the neighbourhood of old Arab settlements. The Swahili name has been derived from the Persian *kunar*.

JAMBALAM, *Syzygium cumini* (L.) Skeels. *Mzambarau*, *Mtofaa*. This tree is wild in Malaysia, in India and on the East African coast and forms a small forest on the island of Zanzibar. It is believed to have reached East Africa through the Persians from the Persian Gulf and is probably the tree that Ibn Batuta saw and described along with other fruits in Mombasa in 1331. It is usually associated with mango trees down the coast and is eaten by the coastal peoples but no attempt is made to grow the tree for its fruits. There are said to be a number of races in India and Malaysia; the fruits of those in East Africa are poor and indifferently eating.

LITCHES, *Litchi chinensis* Sonner. *Mgulabi*. A Southern Chinese fruit tree that Sir John Kirk records as introduced into Zanzibar at the beginning of the nineteenth century. It was introduced into Nyasaland as early as 1886 and has been tried in Tanganyika; also in 1934 in Uganda. It does not seem to have been established except in Zanzibar. There are many varieties.

LOQUAT, *Eriobotrya japonica* Lindl. This fruit is a native of China and Japan which was probably introduced into East Africa by missionaries at the end of last century. It does well in places over 4,000 ft. and is becoming naturalized in some localities. Those in cultivation at Amani were introduced in 1900 from Réunion. The fruits of those in Tanganyika are small and of a very poor flavour.

MALAY APPLE, *Eugenia malaccensis* L. *Mtofaa*. A Malaysian tree which, according to Garcia da Orta, was introduced from Malacca to Goa by the Portuguese and it is suggested that they or the Arabs carried it to East Africa, but the exact date of its introduction is not known. It is not common on the mainland but is fairly plentiful in Zanzibar.

WHITE WAX APPLE, *Eugenia javanica* Lam. *Mtofaa*. A fruit tree native of the Andamans and Malay Archipelago and much cultivated in Java. It is recorded on native markets in Zanzibar and was probably introduced by the Arabs at about the same time as the clove. It was introduced by a Mr. von Horn from Java to Derema, Tanganyika, at the end of last century; a solitary tree was in cultivation at Amani from 1902 but has recently died.

MANGO, *Mangifera indica* L. *Mwembe* the tree, *embe* the fruit. Opinion is divided as to the original home of the mango because it is now naturalized in many places, but it seems probable that it is eastern India, Assam, Burma or possibly Malaysia, as most species of *Mangifera* are indigenous to Malaysia. It has been cultivated by man for 4,000 years and its prominence in Hindu mythology and religious practices leaves no doubt as to its antiquity.

The Chinese Buddhist and traveller, Hwen T'sang, visiting Hindustan between A.D. 632 and 645 was the first person to bring the mango to the notice of the outside world. In 1328 Friar Jordanus, French Dominican missionary and explorer in Asia (c. 1321-1330), visiting the Konkan learned to appreciate the progenitors of the Goa and Bombay mangos, finding them sweet and pleasant. Ibn Batuta, in 1334 noted that "the mango tree resembles an orange tree, but is larger and more leafy, no other tree gives so much shade". According to Capt. Guillains, commander of the French corvette, *La Dordogne*, who visited Zanzibar and the coast towns between 1846 and 1848, Ibn Batuta in 1331 mentions the mangos at Mogdishu on the Somaliland coast and describes how they were eaten. They were cultivated at Mombasa, Kilwa and other Persian settlements and are believed to have been introduced into East Africa by the Persians about the tenth century. They are now naturalized all down the East African coast and are frequently found wild up-country. The *Cronica dos Reys Dormuz* in 1569 says that mangos were brought to Ormuz from Arabia and Persia.

It is not certain if the mango was introduced into West Africa by the Portuguese but Adanson says they were well established there in 1757. In Brazil they are believed to have been planted by the Portuguese first at Bahia, probably not earlier than 1700. There are numerous native names for the many varieties met with, some of very good flavour, others extremely fibrous and tasting of turpentine.

MANGOSTEEN, *Garcinia mangostana* L. This tropical fruit is native of the Malay Archipelago and the Moluccas. It is recorded by Garcia da Orta in his *Colloquies* (1563). It was apparently introduced into Zanzibar by Sir John Kirk about 1850 and it is recorded by him in 1892 that there were trees of some size in the island but they had not flowered. It was introduced into Uganda in 1901; also in Kenya. It was planted from seed at Amani in 1907 and the trees are flourishing and fruit very freely, the first crop being produced in 1934.

PAWPAW, PAPAYA, *Carica papaya* L. *Mpapai*. This fruit originally tropical American, is now naturalized in places in East Africa. The exact area from which it originated has not been determined but it is believed to be the result of a cross between some species of *Carica* native of Mexico. Oviedo, in Hispaniola from 1513 to 1525, says that Alphonso de Valverde had brought its seeds from the coasts beyond Panama to Darien, thence to San Domingo and to other islands of the West Indies. The Spaniards took the plant to Manila, together with the name *papaya*, which it has still retained there and in many other countries. Rumpf between 1653 and 1693 wrote that everyone agreed that either the Portuguese or the Spaniards had brought it to eastern Malaysia. The Dutch traveller, Linschoten (c. 1563-1611), after his visit to Goa between 1583 and 1589, wrote of a fruit in Malacca called *papaiois* which had been brought from the West Indies via the Philippine Islands, so it seems that the fruit had not reached Goa by that time. Rheede figures it in his *Hortus Malabarius* and the plate must have been drawn on the Malabar coast not long after 1667 when he became Governor of Ceylon. Loureiro (1715-1796) in the middle of the eighteenth century says the pawpaw in Zanzibar and it is believed to have been brought by the Portuguese to East Africa in the sixteenth or seventeenth century. The possibility of its introduction into East Africa from Malaya by way of Madagascar should also not be overlooked.

MOUNTAIN PAWPAW, *Carica candamarcensis* Hook. f. This Andine plant was introduced

into Tanganyika from India in 1900 and planted at Amani and in the West Usambaras. The altitude for it is too low at Amani but it is now becoming naturalized in the West Usambaras.

PINEAPPLE, *Ananas comosus* (L.) Merr. *Mnanasi*. This is a tropical American plant that has been in cultivation there from very remote times. Soon after the discovery of America it was taken all round the world by the Portuguese and Spaniards. Santa Cruz was the place from which the Portuguese are said to have taken it. They became acquainted with it under its Tupi name *nana* and as *nanas* they have carried it far and wide. The Spaniards in the West Indies called it *pinas* because of the fruit's resemblance to a pinecone, and in *nanas* and *pinas* we have the origins of the Swahili and English names for the pineapple. The fruit was presented to the Emperor Charles V (1500-1558) in Spain; there is a picture of the presentation of one in 1672 to Charles II of England; and there is a story of the Jesuit priests propitiating the Emperor Akbar (1556-1605) in India with the gift of one. It was introduced into Bengal in 1594 and as Rumpf said of it that it was the noblest of all the fruits in India it must have quickly established itself in that country. It is possible that the Portuguese established it in their East African settlements about 1510 to 1550. It was recorded in Zanzibar in 1799 by Lieut. Bissel. The plant is now wild in places on the East African coast, especially Mafia and Pemba, particularly on the eastern side of the latter island.

POMEGRANATE, *Punica granatum* L. *Mkomamanga* the shrub, *Komamanga* the fruit. This is a native of Persia and Afghanistan and is first met with by name on monuments of the XVIIIth and XIXth Dynasties (c. 1580-1322 B.C.) in Egypt and appears in burial offerings as early as the XIIth Dynasty (c. 3459 B.C.). It is believed to have reached Egypt by way of Mesopotamia and Phoenicia, and to Greece from the east and spread along both sides of the Mediterranean because in Pliny's time (c. A.D. 23-79) several races were known to the Romans. It spread at an early date into northern India and from there to Malaysia and Cambodia, retaining everywhere names connected with an Iranian name, *dulim* or *dulima*. The earliest known records of it in China are the third or fourth century of the Christian era.

The earliest known record of it in tropical Africa appears to be that by Adanson, who

records it in Senegambia in 1757, in East Africa that by an officer of a British man-of-war who saw it along with other fruits in Zanzibar in 1811. It is suggested that it was introduced by the Arabs from Muscat at the beginning of the eighteenth century. Considering its Persian origin and its importance not only as a fruit but as a vermifuge, its introduction to East Africa was possibly much earlier and it was probably brought to East Africa along with the mango by the Persians about the tenth century, if not earlier.

RAMBUTAN, *Nephelium lappaceum* L. *Mshokishoki*. This fruit tree is a native of Malaysia, was recorded by Burton in Zanzibar in 1857, and is believed to have been introduced there from Réunion by the Arabs at the beginning of the nineteenth century. Its fruits are to be seen in Zanzibar markets when in season.

ROSE APPLE, *Eugenia jambos* L. *Mtofaa*. A small tree of Indo-Malaysian origin and of ancient cultivation. It is fairly frequent in Zanzibar and is found in scattered places on the coast of East Africa. Opinion is divided as to when it reached East Africa, one authority going so far as to say that this is the tree described by Ibn Batuta in Mombasa in 1331, not the Jambalam. Most probably it was introduced by the Arabs into Zanzibar about the same time as the clove at the beginning of the nineteenth century.

SAPODILLA, *Achras zapota* L. *Ratabu*. This is a native of Central America and the West Indies and is now cultivated in the moister tropics all round the world. It was commented on by Oviedo, who was in the West Indies between 1513 and 1525, as it was cultivated there before the time of Columbus. It was taken by the Spaniards to the Philippine Islands and was distributed to the west from Manila. It also appears to have reached India from the West Indies. It grows and fruits in Zanzibar, but the date of its introduction and from whence is not known. It was introduced, most probably from Zanzibar, to Bagamoyo in Tanganyika by the Catholic Mission towards the end of the last century. Seed was also brought in 1900 from Réunion and planted at Dar es Salaam, where the tree fruited between 1902 and 1903. Oviedo considered this the best of all fruits; the Sapodilla is also the chief source of chicle gum used for chewing gum.

SOUR and SWEET SOP; CUSTARD APPLE or BULLOCK'S HEART, *Annona muricata* L., *Mstafeli*. *A. reticulata* L., *M. kiajemi*,

A. squamosa L. *Mtopetope*. The sour sop, *A. muricata* is a native of tropical America. It is believed to have spread through the tropics from both sides of America and it is suggested that both the Dutch and Spanish had something to do with its distribution. The fruit is frequently seen on native markets on the East African coast. The sweet sop, *A. squamosa*, is a native of the West Indies, and is not so common on the East African coast as the sour sop. It is believed that the Spaniards took it to the Philippine Islands from Mexico and the Portuguese to India, where it has run wild extensively in those parts where the climate is suited to it. It may have been established in East Africa at the same time as the Cashew-nut, or later, from India or the Persian Gulf. The custard apple or bullock's heart, *A. reticulata*, is also a native of the West Indies and was introduced into India and Malaya soon after the discovery of the New World. It was so widespread in India by 1653-1692 that Rumpf was doubtful if it were native or not. It is thought to have been introduced into East Africa by the Arabs from the Persian Gulf. Sir John Kirk in 1892 records it as growing well in Zanzibar.

TAMARIND, *Tamarindus indica* L. *Mkwaju*. This is regarded as a native of Africa south of the Sahara, Arabia and western India. It is believed to have been a cultivated tree in Egypt in very early times as the Greek philosopher, Theophrastus (c. 372-287 B.C.), was aware of it in the fourth century B.C. It is said that the Arabs and Persians came to know the tree from India, calling it *tamar-hindi*, Indian Date. The tamarind is most frequently associated with ant-hills, the soil of which has a lime content.

TREE TOMATO, *Cyphomandra betacea* Sendth. *Nyanya*. A native of Peru, introduced into Tanganyika from Southern India in 1901. It does well in places that are not too hot and is becoming naturalized in the Usambara Mountains.

WATER MELON, *Citrullus vulgaris* Schrad. *Mtikiti maji*, *M. mkubwa*. Native of the drier parts of tropical and southern Africa, but has been cultivated in Egypt from very remote times and has been traced back to the IVth Dynasty. It was early in Palestine and reached India in prehistoric times, but did not reach China until much later, the tenth century according to one authority, whilst another says between A.D. 1090 and 1155.

(To be continued.)

RURAL RECONSTRUCTION IN SOUTH AFRICA

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Among the numerous contributions towards a better post-war world is a recent report* on the reconstruction of South African agriculture, by a committee of the Department of Agriculture and Forestry in the Union. The Committee was presided over by the Secretary for Agriculture and Forestry, and included the Heads of the Divisions of Animal and Crop Production, Economics and Markets, and Soil and Veldt Conservation, and a member of the National Marketing Council. Such a blend of the political, scientific and economic might be expected to result in a broad approach to the problems, and the report raises wide issues.

The Committee point to the natural disabilities of South African farming. Except in a small area in the south, there is only one rainfall season and a regular six months' drought. The effectiveness of the rainfall is reduced by its irregularity and the fact that much of it falls in torrential storms with a heavy run-off. The soil is readily pulverized in the dry winter months so that dust storms in winter and rain storms in summer combine to produce serious soil erosion. The agricultural potentialities of the soil are limited. Only six per cent is cultivated and no more than fifteen per cent ever likely to be cultivated. The remainder is too rocky, arid or mountainous. The patchy distribution of good arable land imposes a limit on mechanization. There is little further scope for irrigation. The absence of inland waterways, combined with the bulky nature of exports and the wide dispersal of production impose a heavy handicap in the shape of transport costs. Consequently the main line of development in the future should be in the direction of pastoral farming. Here, however, the prospect of recurring droughts, the prevalence of stock diseases and the difficulty of growing supplementary feed have to be taken into account.

To these natural disabilities others have been added by human agency. Farms have become uneconomically subdivided owing to pressure on the land and the prevailing inheritance customs. Land has been ploughed up in areas where arable farming is, at best, a gamble. There has been over-concentration on cereal farming in areas not naturally suited to it. The

struggle to wrest an adequate living from the soil has resulted in continuous cropping without rotation or manuring, and over-stocking, leading in turn to soil erosion and soil impoverishment on a large scale, declining crop yields, and extensive encroachment of bush and cactus. Another potent cause of soil deterioration has been the practice of keeping additional farms as labour reservoirs or for the sake of the rents received from native occupants, farms which are placed at the disposal of natives with little or no control over human or animal numbers or methods of utilization. Most of these farms are to-day in a shocking state of denudation. The uncontrolled squatter system which has been adopted by many farmers is also harmful in its effects. Land settlement has not proceeded along sound lines but has been dictated rather by expediency than with a view to facilitating greater permanency in agriculture as a whole. Damage has been done by the methods of disposal of storm water from roads and railways, and dams have become silted up as a consequence of erosion in the catchment areas. The market value of land has been driven far above its true productive value under a stable system of farming, as a result partly of the farmers' over-optimism or land hunger and partly of investment by the non-agricultural classes when money has been plentiful. The farmer has been tempted to borrow too heavily on mortgage. In time of rising prices he has borrowed on the optimistic prospects and when things have been going well he has endeavoured to maintain a high standard of living instead of reducing his commitments. "Over-capitalization is a very real disability of farming to-day."

Those whose work lies among farmers generally deem it advisable to express a sympathetic attitude towards the farming community and ascribe over-capitalization and soil exploitation to circumstances beyond their control. "Many of the short-comings of farming can be traced directly or indirectly to the economic difficulties with which farmers have had to contend . . . The farmer is the active and direct agent responsible for the maltreatment of our agricultural resources, but it would be most unfair to charge him with the sole

* Union of South Africa Department of Agriculture and Forestry. *Report of the Reconstruction Committee*, Government Printer, Pretoria, 1943-44.

responsibility The man on the land has been caught in the vortex of an economic system not of his making, which, in a large degree compels him to exploit agricultural resources in order to enable him to meet his commitments, and at the same time to maintain a reasonable standard of living . . . The farmer has had to be satisfied with prices which were not commensurate with the inherent value of many of his products. He has thus been compelled by circumstances beyond his control to mobilize all the available resources on the farm for maximum production of certain products for sale in order to obtain the wherewithal to live. Land abuse and other malpractices were thus foisted on the farmer because conditions made it impossible for the use of land to be accompanied by reasonable returns to the user."

It is all very well to be diplomatic provided we are not ourselves misled as to the sequence of cause and effect. Is the above a correct diagnosis? Is soil exploitation more prevalent when farmers are hard up and less so when high prices provide a temptation to mine large profits out of the soil? Do low prices create high land values with their concomitant of heavy mortgage commitments? There are no doubt many cases where soil exploitation is dictated by the necessity to meet current commitments, but is not the foregoing diagnosis in its general tenour a case of putting the cart before the horse? Is not the real sequence of cause and effect as follows:—

- (a) The minimum level of farm incomes is set by the ability and willingness of the marginal farmers to find more attractive employment.
- (b) Profits above the minimum level, so far as they are due to superior land and situation, become absorbed in land values.
- (c) Profits above the minimum level, due to superior ability of individual farmers accrue in the main to the individuals concerned, but to some extent influence competition for land and hence land values, especially where agriculture occupies a large place in the national economy.
- (d) Land values under a tenancy system become expressed in rents, and under an owner-occupation system become absorbed largely in mortgages.
- (e) Up-swings of prices are followed by rises in land values, and price-falls result in over-capitalization,

- (f) Preference for present as contrasted with future incomes under a capitalistic system dictates that present profits will be extracted from the land at the cost of future profits which might be obtained under a more conservational policy.

The level of incomes expected from farming bears in the long run some relation to those obtainable in other walks of life. If industrial prosperity is at a low level some people will be content, or constrained, to stay in or enter the agricultural industry even at a low level of income and will compete for land. It is not suggested, of course, that mobility between industry and agriculture is by any means perfect, but it can hardly be doubted that in the long run the two interact. If industry is prosperous and agriculture depressed more young people will leave the farms. If it is the other way about, more people with capital will invest it in land. Incidentally there is often a certain lack of realism in comparing agricultural with industrial incomes. The money standard is used too exclusively, without due allowance for the comparative advantages of life on a farm and in a town. If the farmhouse and home-produced food were valued in farm accounts at the cost to the townsman, farm accounts, particularly for the smaller farms, would show a different aspect. The freedom and variety of the life, the sense of being one's own master, love of the country and mere inertia against leaving the farm and the neighbourhood, all play their part in a man's evaluation of the relative advantages to him of farming and alternative occupations. It is necessary to take account of the average level of education, training and skill in agriculture at the lower levels, in comparison with what such capacity would be able to earn in other occupations (allowing at the same time for the capital required in the farming industry).

In a competitive economy the level of incomes of the marginal farmers profoundly influences that obtainable throughout the industry. This cannot be prevented except by insulating agriculture from other occupations, which would mean restricting the numbers in the industry, controlling prices and production, and abolishing private property in land. The marginal farmers will compete for land and labour until the return is brought down to what they could obtain in some other occupation. Some farmers will be able to earn higher incomes because of superior skill. Others will be able to earn more because they are farming

on better or more favourably situated land. There is always a strong tendency for this latter class of advantage to become capitalized in the form of land values and to be creamed off by mortgagees. This is evident enough in South Africa and elsewhere. On the continent of Europe Mr. Lamartine Yates observed that whatever assistance was afforded to agriculture, the level of farm incomes tended always to a basic level comparable with wages in industry, and the surplus went into rents and mortgage interest. Under a system of free enterprise this is natural and, in the long run, inevitable. The higher agricultural prices, the more will be paid in interest and rent. The gain of the farmer from a rise in prices will last only so long as it takes land values to catch up. Low prices can only be said to be a cause of over-indebtedness in the sense that land capitalized at a given level of prices becomes over-capitalized when prices fall, a situation which is common enough but which can be alleviated only by stable returns and not by high prices. Easier credit does not help farmers, as farmers. In fact it helps land values to catch up with current profits. On the whole it seems likely to diminish incomes from farming rather than to raise them, if the necessary distinction is drawn between farming and landowning.

Profits due to superior skill on the part of the farmer also influence land values, since farmers who are able to obtain them compete the more actively for land. If the supply of land were unlimited and opportunities for the marginal farmers in industry and commerce were large there would be no such effect. In a predominantly agricultural country, however, where the land is fully taken up, the desire of successful farmers to increase the scope of their operations must affect the demand for and the price of land. At the same time, marginal farmers cannot be squeezed out of agriculture without increasing the pressure on industrial occupations. The upshot is that a proportion of them will be forced to stay in agriculture at an even lower level of income than before, bringing down still further the marginal level of farming incomes and causing an all-round increase in land values. An American farmer expressed the same thought in a different way when he said, "the more I improve my farming methods, and the more my fellow-farmers do the same, the more we shall all be under the harrow".

We therefore arrive at the conclusion, unwelcome though it may be to people with certain views about the place of agriculture in national life, that the way to bring about a

more prosperous agriculture is not to settle more people on the land, raise produce prices and provide easier credit facilities, but to offer the marginal farmers better opportunities of leaving the land. The Committee's conclusion, however, is that "the country requires a fairly large percentage of people on the land in order to retain, for the benefit of the nation, the stabilizing influence which emanates from a strong rural population . . . The essence of security for the farmer is a reasonable return for his products . . . It is the intention to focus attention here only on one of the basic requirements for assuring a decent standard of living to the farmer and his family, namely the need for refuting the erroneous idea that agricultural prices cannot be on a parity with industrial prices".

Another fundamental factor which enters into the matter of soil exploitation is the factor of time-preference. Under the modern economic system money to be earned this year is worth more than a prospective income many years hence. Interest can be earned on the money in the meantime. A table of present values of future income will illustrate the point. The present value of a sum due a quarter of a century hence at ordinary rates of interest is only half or less of the maturity value. Also, in the risks and chances of life future prospects may never materialize. Hence there are few farmers willing to sacrifice present profits for the sake of keeping the land in good heart for the future. The more speculative the kind of crops the farmer is producing, and the more the farmers look to land speculation as a source of profit, the less he will be guided by long-term considerations of the good of the land. It may be correct to absolve him from blame, but not for the reasons usually given. The real reason lies in pride, envy, luxury and avarice, the search for money profits and quick returns, which is the basis of our modern civilization. It is part of "the sickness of an acquisitive society".

On the technical side the report traverses familiar ground. Destructive systems of farming, with over-emphasis on sale crops, must be discontinued. There must be greater attention to mixed farming and the raising of stock feed on arable land; more emphasis on the protective foods—meat, milk, butter, eggs—and less on starches; greater diversification of production on individual farms, with rotation of crops including legumes; lower intensity of farming where the soil will not stand the present drain upon it; in some areas conversion

of arable to pasture; better grassland management and eradication of over-stocking; cessation of sheep farming and grass burning in long-grass areas; banishment of the goat; control of grass burning; more hay-making; return of all animal and vegetable wastes to the soil; contour-farming and strip-cropping on sloping land; establishment of fodder trees; eradication of prickly pear; more dam construction and afforestation; retirement of catchment areas from agricultural use.

To suggest effective means of bringing about the desired improvements is less easy. How are you going to prevent people trying to get rich quickly or trying to force the means of a preconceived standard of living out of a reluctant soil? How are exploitive systems to be prevented if the price system encourages them? How abolish continuous growing of maize and wheat, if a Mealie Control Act is raising profits on the one and heavy import duties on the other? How encourage stock farming if the main bulk of the population is kept on such a low income level that it cannot purchase the products?

The Committee have a simple solution. Everything should be subsidized. Some schemes already exist under which construction of dams, boreholes, contour banks and silos and the keeping of improved bulls, are subsidized. The Committee propose in addition "a comprehensive scheme or schemes for the subsidization of sound methods of land use", including provision of fencing material on easy terms, bonuses on sound methods, subsidies for thorn-bush and prickly-pear eradication, erosion control, water conservation, and proper camping of grazing areas. They propose assistance for debt reduction on farms which are over-mortgaged but not hopelessly so. A further suggestion is that if the low-income groups cannot pay the price for agricultural products demanded by the marketing boards, the State should subsidize their consumption. Legislation is proposed to declare badly eroded areas "conservation areas", on which a bonus of 50 per cent of the final valuation would be paid on completion of protective measures, with provision of easy credit to cover the necessary expenditure.

Taken in conjunction with the implied suggestion that agricultural prices have in the past been inadequate, the proposals amount to a sort of race between rises in prices and corrective subsidies. It is well that means are at hand to finance the programme without having the cost come back in the final event on

the farmers themselves. Figures given in the report put the share of agriculture in the national income as 13 per cent in 1938-39, as against 18 per cent for manufacturing, 21 per cent for mining, 16 per cent for commerce and finance, 15 per cent for public services and professions, 5 per cent for domestic service, 6 per cent for transport and 7 per cent for rent. However, figures of national income are subject to many pitfalls for the unwary. If the prices of agricultural produce are raised it is made to appear that the share of agriculture in the national income is raised, but that does not mean that the contribution of agriculture to the real income of the nation is in any way increased. Again, the income of commerce and finance, public and professional services, transport and rent comes in the last resort mainly from agriculture, mining and manufacturing. What will be the position of agriculture if, as the Committee say, "a rapid waning of the gold-mining industry is expected in the near future". How then will it be possible to maintain a "decent" standard of living within a larger agricultural industry without a corresponding degradation of the standard of other sections of the population and of the nation as a whole?

The Committee evidently believe that the measures they propose will enable agriculture to work on a lower cost structure in the future and on a lower price basis, but this is in conflict with their complaint that the farmer has not in the past been able to maintain a reasonable standard of living. A certain trend towards realism is, however, evident in their suggestion that the Control Boards which they propose for the marketing of agricultural produce should be government-appointed, with consumer representation, looking to the good of the country rather than to the sectional interests of agriculture, and their proposal that the high import duty on wheat be reduced and the price allowed to find a lower level.

The proposals regarding over-capitalization of land values are interesting. Over-capitalization is said to be "one of the greatest evils" and "one of the heaviest items in our agriculture". It is not considered feasible to set a mortgage limit to be allowed on any piece of land. There are too many factors concerned, each difficult to measure; they propose the setting up of a Bureau of Farm Values which would be "an impartial and scientific Institute for the collection of the most accurate and complete information on the fundamental facts connected with the true farming value of every

piece of land used or usable for pastoral, agricultural and forestry production". A card index would be maintained for general reference. The Bureau would be able to pay a staff of trained and experienced valuers. In this connexion the employment of local farmers as valuers has proved to have the serious drawback that local bias cannot be eliminated. Presumably the values would be based on income-producing capacity.

The most radical proposal, however, is that the State should become the sole mortgagee of agricultural land. The State is already bondholder in respect of some 30 per cent of the mortgage indebtedness. National mortgage loan banks should be obliged to work on the assessment of the Bureau of Farm Values. The proposal is not elaborated. Presumably all private mortgages executed after the date of the measure would be declared invalid; it is hardly to be supposed that existing mortgages would be affected. This would not produce any early improvement on the existing situation; it would only prevent it from getting worse. The problem of outright purchase, too, would remain. The Committee are of the opinion that this could hardly bring about a general inflation of land values, which seems to be an unduly optimistic conclusion. People do not bid excessive prices for land out of mere ignorance. At the time of purchase the land values are actually there according to the computations of the persons concerned. Prohibition of borrowing except on Bureau values might put a brake on purchase to some extent, though any jacking-up of farm produce prices would act in the reverse direction. Values being still there, it is more than likely that money would find some way of flowing towards them, e.g. by the process of payment of cash premia when purchasing the farms, over and above the Bureau values, or outright purchase by non-agricultural investors with a view to letting the land on tenancy.

While the compulsory nationalization of land is rejected the acquisition of land by the State on a voluntary basis for creation of tenancy

holdings is approved. The State as land owner would be able to stipulate that necessary safeguards in connexion with the conservation of the land be observed. Monoculture would be prohibited, the rate of stocking limited, new ploughing controlled, and anti-erosion works have to be maintained in good order. Rents would be based on average commodity prices over a base period and would be reviewed at intervals of, say, ten years. The land would be issued under a perpetual and heritable lease. Nothing is said about sale of lease. If this were allowed the leasehold would become scarcely distinguishable from the kind under which alienated land in Kenya is held and there would be nothing to prevent over-capitalization in time. The problem of acquisition when land is generally over-valued, without passing the burden on to the tenants, is not discussed. Perhaps it is expected that the State would again foot the bill.

It is unfortunate that in a report of this character undefined terms bearing the stamp of political clichés should be used. What is the "basic value" of primary produce? What is meant by "prices for agricultural produce which approximate to that of the industrial product"? (What is being compared, a bag of maize with a motor car, the product of an hour of ploughing with an hour of turning a lathe, or the product of a year spent by a farmer riding round his farm with that of an executive operating a steel plant?) What is "stabilized" farming practice? (For all the reader knows it might mean "petrified".) Presumably the Committee knew what they meant, but the reader is left to use his imagination.

A noticeable omission is any reference to agriculture as carried on by Africans. Perhaps this is primarily the concern of the Native Affairs Department, but one would have thought it merited some notice from a committee dealing with Union agriculture in its broad aspects. The omission is the more unfortunate as here and there some attempt is being made to repair the ravages of the past.

Botany should be dealt with by a class of sylphs; instead of which its priests are often old and unenthusiastic men. Plod through page after page of botanical description, and where do you find any hint as a rule of the matchless beauty they should be describing? Little if any mention is made of the colour of the "corolla" (as it is correct to call the showy part of the flower), but what the botanist likes to note with so much satisfaction is that the plant is

either glabrous or scabrous, that it is possibly caulescent and that the outer whorl is covered with black emergences. He likes the perianth cup to be short and fleshy and prefers the anthers to be sessile. Not a single exclamation of praise or prayer at the flower displayed. Of course he is right: science must be unemotional.

Sir Harry H. Johnston in *British Central Africa*.

CORRESPONDENCE

THE TIMBER QUESTION

Forest Office, Londiani,
19th August, 1944.

The Editor, East African Agricultural Journal.

Sir,

Re the note added by the Conservator of Forests to my article in the July issue of this Journal.

I expressly stated that about $13\frac{1}{2}$ c.ft. of sawn timber per head was "consumed or exported." I excluded 25,000 c.ft. exported for war purposes.

In his Annual Report for 1939, the Conservator of Forests stated: "A considerable increase appears in the log consumption figure for 1939 over the previous year. *This was due to an expansion in local trade which was evident in the first nine months of the year, but which was intensified in the last three months of the year, by military demand.*" (Italics mine). Exports, other than 25,000 c.ft. for war purposes, amounted to 125,000 c.ft. Making allowances for exports and for hardwoods, the local consumption still seems to have been about 8 c.ft. of soft woods per head and not 5 c.ft. as stated by the Conservator. But in fact my figure of $13\frac{1}{2}$ c.ft. was for sawn timber consumed and exported and not just for softwoods consumed locally.

I still maintain that "suitable natural timber stocks are running low"—if we are interested in catering for the African demand which is bound to arise. *Juniperus procera* ("cedar"), our commonest tree, is normally riddled with fungus and is therefore very expensive to convert. The fact that it is normally resistant to termite attacks hardly matters in a well-built house; but it is by no means an ideal timber for joinery and carpentry. *Olea hochstetteri* (*msharagi* or olive), another very common species, is difficult to season, and even more difficult to nail when seasoned. It is heavy, non-durable and altogether unsuitable for cheap buildings. *Ocotea* ("camphor") is common in the Aberdares and on Mount Kenya. It is expensive to convert and to put on the market. It is usually regarded as a cabinet

wood. *Cordia* (*muringa*), *Vitex* (*muhuru*) and timbers of this class are other cabinet woods which are not available in quantity.

The two *Podocarpus* species are the mainstay of the Kenya milling industry. In 1939 accessible Podo stocks were estimated at twenty-five to thirty million cubic feet of logs. Some five million cubic feet have probably been cut since then. There may be ample reserves for the probable demand of the European and Indian populations—although I believe that the natural increment of Podo in our forests is practically nil. The volume of millable timber in untouched natural forest remains fairly stable. Increment put on by young stems is offset by deaths and decay in the over-mature age classes. In cut-over areas natural increment of Podo in economically exploitable quantities is extremely slow. Poles and saplings are generally scattered and it would probably take some hundreds of years for another exploitable crop to grow, unaided, on such land. To all intents and purposes, so far as Podo is concerned, we are living on capital since large areas of immature natural Podo are not common.

This brings us back to our exotic softwood plantations. Opinions as to yields and rotations may differ, but these are, relatively, of minor importance at the moment. What does matter is the fact that we have many hundreds of thousands of acres of land which must be kept under forest for water conservation purposes, and which, although it produces little or no useful timber now, is eminently suitable for the growing of softwoods. Intelligently managed, this land would give us all the suitable timber we shall want in future for the whole population of Kenya as well as for an export trade. And, most important of all, a thriving timber industry, besides giving direct employment to very many thousands of people, would enable the country to undertake urgently needed forestry schemes in many districts without having to budget for a cash return on money so spent.

R. M. GRAHAM,

Assistant Conservator of Forests.

A PROBABLE VIRUS DISEASE OF SWEET POTATO

By C. G. Hansford, Plant Pathologist, Uganda

(Received for publication on 26th August, 1944)

In March, 1944, what is suspected to be a virus disease of sweet potato was discovered at Kwanda by Mr. J. D. Jameson, amongst a collection of native varieties kept here for reference. A detailed survey of the distribution of the disease in Uganda has not yet been possible, but records have been obtained from widely separated areas and there is thus reason to suspect its general distribution. Recently reports have been received of its occurrence in Ruanda-Urundi and in the adjoining parts of Tanganyika. I am informed by the authorities of the Congo Belge that they suspect its occurrence in serious amounts in the area west of Lake Albert, where the crop has suffered severely and has virtually been abandoned as a food supply to the Kilo Mines. In view of these records the disease is thus potentially of serious importance in those parts of East Africa where the sweet potato is a major source of food supply.

Hitherto investigations have been limited to field observations and detailed experimental research is only being commenced, so that no information is yet available on the possible origin of the disease, on its method of transmission from plant to plant, or on its relation to virus diseases of other crop plants in East Africa. Both in the Congo Belge and at Kawanda large numbers of white flies (*Aleyrodidae*) have been noticed in affected plots, and we suspect these as possible vectors of the disease. They have not yet been identified but appear to be close allies of the species of *Bemisia* known to be the vector of the mosaic disease of cassava.

The symptoms shown by infected plants show considerable variation, according to the variety of the host. Some of the narrow-leaved varieties of sweet potato show severe stunting, accompanied by a general yellow-green appearance of the field; individual plants grow very slowly, have small leaves and relatively an excessive branching of the vines, with short internodes. The leaves show usually an indefinite mosaic pattern of light and dark green areas, or in other varieties a light yellowish green banding along the veins. Older leaves show often a bronzed colour, either of the whole leaf or of indefinite scattered parts of the lamina. No outgrowth ("enations") have been seen in any variety examined to date. The broad-leaved varieties of the crop show more variation in

leaf symptoms, and in general reaction to infection. One variety ("Six Week"), an importation of unknown origin, now shows almost complete infection, and the leaves exhibit a pronounced mottling or mosaic, with little or no dwarfing of the plant; older leaves become slightly bronzed. Other broad-leaved varieties may show either the mottled or mosaic pattern, or an indistinct vein-banding, in some cases with more or less distortion of leaf shape, in others with more or less crumpling or cringle of the leaf, parts of which may be distinctly thicker and tougher than healthy leaves. Most varieties show the bronzing of older leaves, which differs in appearance from the discoloration of old leaves of healthy plants, though the differences are difficult to describe. The symptoms on infected plants of varieties which normally develop red or purple pigment in leaves and stems are extremely obscure and where dwarfing of the whole plant or of individual leaves is absent the disease is difficult to detect on this group of varieties.

No information is as yet available on the actual effect of the disease on yield; in April, 1944, rows of plants from healthy and diseased parents were planted alternately at Kawanda, and are not yet mature. Judging from their general appearance in the field, it seems very unlikely that the infected rows will yield any crop at all, but the variety used in this trial is now obviously much more susceptible than many others on the Kawanda farm. Hitherto no variety grown at Kawanda appears to show complete immunity to attack, though differences in the behaviour of varieties when infected are obvious. The disease undoubtedly spreads from infected to healthy plants under field conditions, and an insect vector is almost certainly concerned in this spread. We have still to accumulate experience on the rate of this secondary spread under field conditions in Uganda.

The question of control of a disease of this type in a crop grown by almost every native in Uganda is obviously a matter of the development of a resistant variety of the crop. The symptoms are so obscure that even the possibility of advising the selection of cuttings for planting from only healthy parents is ruled out as a temporary measure for reduction of the disease. The first step towards the production of resistant varieties must be to discover the method of transmission from plant to plant,

and to work out a method of inoculation efficient enough to be utilized to test out large numbers of strains in comparative trials on a field scale. As mentioned above, hitherto no native variety of the crop appears to be immune to attack, though so far some appear to be more tolerant of infection than others. Present indications are that a large number of seedling varieties must be grown for trial, coupled with a search for immunity amongst native varieties of sweet potato and among other species of *Ipomoea*. Once such a source of genes for resistance has been discovered, it should be comparatively an easy matter to transfer them to other varieties, and as the crop is propagated vegetatively, further segregation of the hybrid progeny will not complicate the problem. Meanwhile, should the disease show rapid spread, it is probable that the more susceptible varieties will die out completely, but it is likely that many complaints of shortage of food caused by "degeneration" of the sweet potato will be received during the next few years.

With regard to the occurrence of large numbers of white fly on the crop at Kawanda during the present season, it is of interest to note that no previous records of such an insect on sweet potato have been made in Uganda, in spite of the intensive research on the pests of this crop conducted by Hargreaves during the period 1920-1932. This may be an indication that it is a recent development in Uganda, and the present succession of dry years may be concerned in this.

The whole of the above account of the disease is necessarily of a very preliminary nature, and many of the opinions expressed may have to be modified as further information is obtained. At the same time, the disease is potentially of very serious nature in East Africa, and this account is published primarily that other workers may be able to record its presence or absence in their particular areas, and to note any varieties of the crop which appear to show high resistance. The early dis-

covery of such resistance is extremely important, so that it can be utilized in the breeding of a series of resistant varieties. In a native food crop such as the sweet potato, many characters quite distinct from yield and resistance to disease enter into the selection of varieties by the native for his cultivation. We have therefore to aim at the production of a whole range of varieties resistant to this virus, so as to give the native a choice among them for such characters as taste differences, yield differences, maturity period and suitability to a wide range of climate and soils.

The identification of the disease in the field is complicated by the attack of species of *Cylas*, which by boring in the base of the vines cause dwarfing and yellowing of infested plants. Judging by the behaviour of plants at Kawanda, those showing virus infection are more liable to attack by these beetles than healthy plants, possibly on account of their much slower growth. Portions of such plants free from the insect attack, when planted in the greenhouse, have reproduced the virus symptoms of their parents, so that there is no room for doubt that the two are independent.

Some varieties of sweet potato show plants with an indistinct variegation, often limited to the veins. This seems unrelated to the virus described above, though it is still possible that it may be due to the attack of a different virus. Cuttings taken from such plants have reproduced exactly the symptoms shown by the parents.

Finally, in view of the potentialities of this disease, it is important that surveys be carried out at the earliest opportunity to determine its distribution throughout East Africa, and that precautions should be taken immediately to prevent its introduction into areas found to be clean. For the present, it should be assumed that the whole of Uganda is infected, together with the part of Tanganyika west of Lake Victoria. Whether the disease is more widespread than this we have at present no information.

The pioneer is always surest that a rich fauna has no value compared with a few more people or dollars. By the time a country has many people and many dollars, and the not so beautiful interior of the social structure has become apparent, the assumed priorities are less obvious. By that time, however, the fauna

has usually lost its richness and, like humanity, has acquired internal disorders. Thus, in parts of Africa the demise of the "noxious" leopard has given rise to a plague of baboons and wild pigs.

Aldo Leopold in *Geographical Review*.

REVIEWS

TESTING FARM SEEDS IN HOME AND SCHOOL:

Albina. F. Musil., U.S. Dept. of Agric.
Bull. 137. Washington, D.C., March, 1943.

This bulletin of 88 pages goes very much further than the title seems to suggest. In fact, the few pages dealing with home-made apparatus and the need for and the general principles of seed testing would, one might think, satisfy the requirements of the home and school. How to make a balance out of a pocket knife, a couple of pencils and a few odds and ends is explained in detail. Although "not as accurate as the expensive analytical balances used in making official tests", it is claimed that using B.B. shot as weights, an accuracy of half of one per cent can be attained in the purity analysis. Twenty pages are devoted to a description of the smaller crop seeds and the varietal differences that occur in them. As examples of the wealth of technical detail in this section descriptions are given with illustrations of four kinds of *Lespedeza* seeds and six kinds of vetch and many of the sorts of small leguminous seeds and the different grasses. Happy the home and school analyst who can readily identify these.

About half the book deals with the identification of the common weed seeds of America, of which about 160 are well illustrated and concludes with a list of their latin and English or American names. A useful feature is a tabular arrangement in what crops the weeds are likely to occur.

For a country which offers to the farmer the most highly developed technical service in the world, to produce a Government publication on home seed-testing is surprising. Perhaps the main object is to stimulate an interest in seeds in the rural schools so that farmers will be in a position to understand the seed laws

and the labels on which the law insists. Still, for those who wish to test their own seed in the home, this is undoubtedly the book for them, but many will prefer, and probably be well advised, to take advantage of the official seed testing stations.

R.M.N.

THE PRODUCTION OF SEED OF ROOT CROPS
AND VEGETABLES: Imperial Agricultural
Bureaux Joint Publication No. 5, July,
1943. Price Sh. 3.

This much-needed symposium describes new developments taking place as a result of the war which has cut off many of the chief seed-producing countries. These developments are described in a series of articles from several countries. A chapter is devoted to European vegetable seed in the Colonial Empire, including East Africa, where it is pointed out that two problems appear to be involved, firstly whether it is possible to become independent of imported supplies and secondly whether an export trade in vegetable seed can be built up. Valuable details are given of the techniques being adopted for a wide range of vegetables and root crops growing in very different climates. The account given of how the U.S.A., largely as the result of applied research, has in the course of the last few years become independent of imported supplies of sugar-beet seed is impressive and suggestive of what might be achieved with other crops elsewhere, given the necessary facilities for plant breeding and selection.

Some of the articles are of necessity progress reports only and it is therefore to be hoped that this valuable publication will be followed later by a supplement giving further information, particularly from the tropics.

IRISH BLIGHT RECORDED ON TOMATO

Irish blight, now widely distributed in potato in East Africa, was observed on tomato at Lyamungu in the Moshi District of Tanganyika Territory, in early October, 1944. This appears to be the only record so far in East Africa, but there is no doubt that the distribution of the tomato infection will be found to follow closely that of potato. It is hoped to publish detailed information on the disease in the next number of this Journal; meantime further cases should be sought and reported to the Departments of Agriculture.

The symptoms on tomato foliage are similar to those on potato, described by Dr. R. M.

Natgrass in this Journal, Vol. VII, page 196. In the tomato fruit there is an irregular brown discoloration, usually starting from the stem end, and associated with a brown watery rot extending deep into the fruit. Fruit from infected plants can develop serious rot in storage or in transit. Several strains of the fungus are recorded but the disease in either crop, potato or tomato, should be considered a potential danger to the other crop. Control measures will depend upon local circumstances: they include segregation of tomatoes and potatoes, spraying, and the burning of old plants.

G. B. WALLACE.

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